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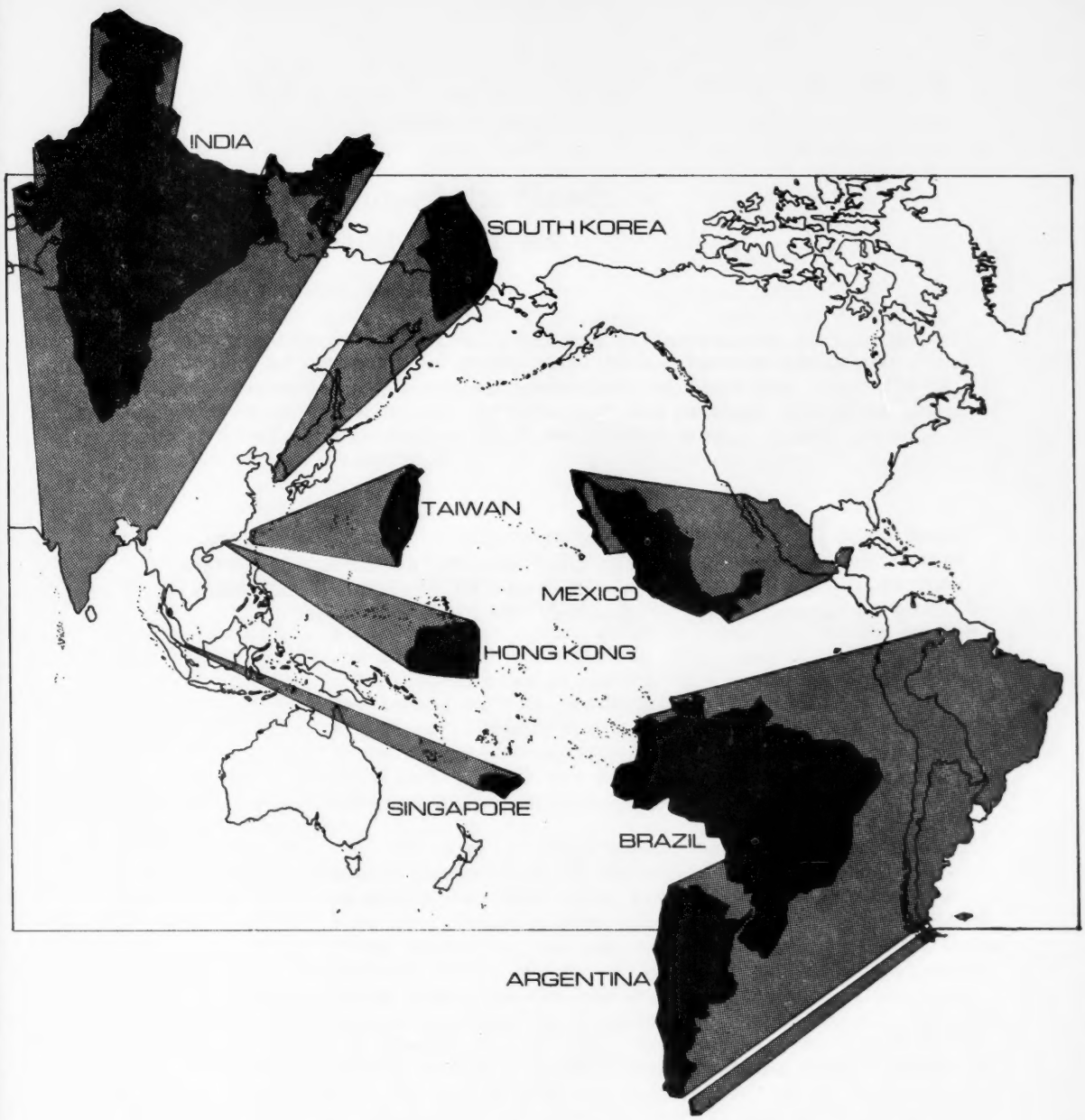
Money values will be expressed in U.S. dollars unless otherwise specified. The spelling "tonne" will be used to indicate metric tonnes (1000 kilograms), and "ton" will refer to traditional U.K.-U.S. tons (2000 lb. or 2400 lb).



NEWLY INDUSTRIALIZING COUNTRIES

THE NEWLY INDUSTRIALIZING COUNTRIES: INDIA, SOUTH KOREA, TAIWAN, SINGAPORE, HONG KONG, MEXICO, BRAZIL AND ARGENTINA HAVE EMERGED SINCE THE MID-1960s AS SIGNIFICANT EXPORTERS OF MANUFACTURES. (Graphics: Barbieri and Green)

The Emergence of the Newly Industrializing Countries

National Planning Association

[A small group of developing countries has emerged as significant exporters of manufactured goods since 1965. Factors leading to their successes in industrial production and marketing, the effects in the advanced countries' markets, and the prospect for these and other developing countries which may become greater exporters in the 1980s are discussed.]

Since the mid-1960s a small group of Third World nations has joined the ranks of significant exporters of manufactures. These nations have been termed the "Newly Industrializing Countries," referred to here as NICs. (We shall also refer occasionally to the advanced industrial countries as AICs, and to the less developed countries as LDCs). The emergence of these developing nations has broadened the number of industrial export competitors in the world economy and brought about changes in the relationship of the industrialized "North" and developing "South" and, even more fundamentally, changes within the South.

For some of these developing nations the level of growth performance in industrialization and overseas marketing has been quite extraordinary. The smaller NICs in particular have within a short time transformed their societies, overcoming much of their poverty, while opening themselves to new problems and vulnerabilities. Aside from possible destabilizing social and political forces generated by rapid change, their export expansion has sharply raised their vulnerability to shifts in external markets, whether from declining market growth or

Composed by the staff of the National Planning Association, an economic research organization, Washington, D.C., including the editors of the Development Digest.

increased protection in OECD importers, or from possible competition from other exporting NICs seeking the same markets. It must be emphasized, however, that these are the problems of success, and that however difficult they may be they can be attacked with a higher level of resources and skills than would have been available in the absence of such successes.

What Constitutes a NIC?

Third World exporters of manufactures can be ranged along a continuum by the value of such exports in a given year, and a cut-off point can be applied at various possible levels to define a NIC. Their rates of growth in the production and/or the export of manufactures should also be considered. A study by the OECD works with a relatively restricted list of NICs: Brazil and Mexico from Latin America; Greece, Portugal, Spain and Yugoslavia from Southern Europe and the Mediterranean; Hong Kong, the Republic of Korea (South Korea), Singapore and Taiwan from East and South-East Asia. A study done by Britain's Foreign and Commonwealth Office (FCO) worked with a wider list, adding Argentina to the Latin American group; Israel and Malta in the Mediterranean; and India, Malaysia, Pakistan, Iran, the Philippines and Thailand on the Asian list. In addition, it suggested that Poland, Romania and Hungary from Eastern Europe deserved analysis under the NIC classification. This study concentrates on South Korea, Taiwan, Hong Kong, Singapore--the so-called "Gang of Four"--and India in Asia; Brazil, Mexico and Argentina make up the Latin American component; the European NICs are not included. The nations listed constitute the eight largest among the non-European Third World exporters of manufactures in 1976.

Table 1 shows the enormous jump in the value of NIC exports from 1965 to the mid-1970s, as well as trends in the total export of manufactures by developing countries. Table 2 indicates the rather extraordinary growth rates in the real values of manufactured exports in this period, and their importance in the total exports of these countries chosen for discussion as NICs.

The question at this point is, why have these particular countries been capable of exporting manufactures at such remarkably dynamic growth rates? Is there a set of unique conditions prevailing in these countries which allow them to penetrate OECD markets in manufactures? Or are the developing country NICs simply the first wave of a trend in the pattern of world industrialization which will bring other developing countries into world markets as exporters of manufactures in due course?

TABLE 1

LEADING DEVELOPING-ECONOMY EXPORTERS OF MANUFACTURES

Country or Territory	*Value (million current US dollars)*			
	1965	*1975*	*1976*	*1977*
Hong Kong (Including re-exports)	989	5,590	7,859	8,911
Taiwan	187	4,303	6,936	7,947
South Korea	104	4,136	6,747	8,498
Yugoslavia	617	2,903	3,382	n.a.
Singapore	300	2,233	2,920	3,496
Brazil	124	2,192	2,332	3,044
India	809	1,961	2,802	n.a.
Mexico	166[b]	2,090[b]	2,000	2,475
Argentina	84	723	975	n.a.
Malaysia	68	664	798	n.a.
Pakistan	190[a]	571	n.a.	n.a.
All developing countries	4,590	35,280	45,580	n.a.
(some European NICs for comparison)				
Poland	1,628	5,758	—	—
Hungary	1,567	4,257	—	—
Rumania	—	2,189 (1973)	—	—
Greece	89 (1968)	1,003	1,252	1,372
Spain	736 (1968)	5,372	6,025	7,203
Portugal	465 (1968)	1,355	1,198	1,385

[a]—Including what is now Bangladesh.
[b]—Including border trade.

Source: UN International Trade Statistics, Volume 1, 1977.

TABLE 2

GROWTH OF MANUFACTURED EXPORTS FROM THE NICs

	Real Average Growth % Per Annum 1965-1975	Manufactured Exports As % of Total Merchandise Exports 1960	1977
South Korea	36.0	14	85
Taiwan	28.8	na	49
Brazil	25.4	3	26
Mexico	21.2	12	29
Argentina	16.7	4	24
Singapore	15.0	26	44
Hong Kong	11.9	80	96
India	2.8	45	56

SOURCES: World Bank Staff Working Paper No. 314, The Changing Composition of Developing Country Exports, January 1979, Table 7; and World Development Report, 1980, Table 9.

Factors Contributing to Achievement of NIC Status

Among the eight NICs examined here there is a significant dichotomy. One group is comparatively small in area, resource- and land-poor, and densely populated. It includes South Korea, Taiwan, Hong Kong and Singapore. Development of their export industries was very intensive, undertaken purposefully as a means of economic survival. The other group, consisting of Brazil, Mexico, India and Argentina is more mixed. These countries tend to be large in population and area, and to have had a longer period of industrial build-up and more variegated policies.

There is clearly a considerable diversity in the total group of eight NICs, but it is possible to identify five conditions which affected all of them to some degree and which were conducive to the creation of a NIC.

Condition I: First is the rate of growth in the world economy and the effect that this has had in providing adequate demand for possible NIC exports. Without external buyers for exports, expansion of a manufacturing sector is impossible unless a domestic market can absorb the goods produced. The period from the mid-1960s to the early 1970s was a high growth period, and this is an important element in explaining the timing and extent of the growth in manufacturing of the present NICs.

Condition II: Second, there are certain internal conditions which are more or less common to the NICs under consideration here. One of these factors that the NICs share is an educational level, or at least a stress on educational improvement that sets them apart from most other LDCs. Hong Kong and South Korea currently have over 90 percent literacy rates, very close to the levels found in AICs only 20 years ago. In the larger NICs where literacy rates are not so high, they have been increasing strongly since 1960, and the same can be said of the spread of higher levels of education. In the NICs with large populations, where percentages for various educational levels not appear high, the absolute numbers are sufficient to indicate that there is a "critical mass" of educated elite to propel the expansion of manufactures for export. For example, India's educational performance may not look strong when expressed in percentage terms, but there were over 3.7 million Indians in higher education in the early 1970s--between five and six times more than in Britain. The emphasis that Nehru and his successors placed on scientific and technical education has created a reservoir of highly educated manpower that should continue to strengthen the foundations of the Indian industrial sector.

Condition III. A third factor that the NICs have in common is that they each have had to transform their closed inward-looking,

import-substituting development strategies into more open export-oriented ones, at least in some degree. The means by which each of these nations did so is quite different, as was the timing and intensity of the change. An outward-looking development policy can be evidenced by measures taken that improve their responsiveness to world markets and their ability to meet demand in those markets. This responsiveness can take the form of exchange rate adjustments and other monetary policies that favor trade, reduced protection of internal markets, and policies that encourage foreign as well as domestic investment. A variety of export promotion devices may be employed, including not only overt promotional activities but subsidies and taxes designed to guide producers toward potential export sectors and to reward the achievement of foreign sales.

Condition IV. Political stability appears to be a condition necessary for the rapid increase of industrial output and its sustained entry into foreign markets. Not all the NICs have shown 100 percent stability, in the sense of an absence of disruptive changes of government in the post-war years, but some have: Taiwan, Hong Kong, Singapore, Mexico and--with one brief slippage--India. South Korea, devastated by war in the 1950s and subjected to two major coups thereafter, nevertheless had a stable period of over 15 years in which its intensive growth policies were consistently pursued; and the same could be said of Brazil post-1964. Argentina would seem to be the main exception here, as in some other respects; its classification within the NIC category will be discussed below.

Condition V. Finally, a factor bearing on NIC formation should be mentioned, although it cannot be positively termed a necessary condition: a relatively poor natural resource endowment relative to population numbers. The countries that have abundant, readily exploitable minerals and especially petroleum, one or a few well-developed agricultural export products such as rubber, sugar, cotton or coffee, or a favorable timber potential--such countries can generally mobilize these products for export far more rapidly than they could expect to develop the export of industrial goods. This would be the most rational course for them to pursue. But if they do not have such opportunities, and if the other conditions favoring exports are present, then the paucity of natural resources should induce them to begin sooner and more intensively to develop their industry for export purposes.

This proposition cannot be generalized to suggest that poor resources *per se* are helpful to industrialization. But their role in conjunction with other factors can be illustrated as follows: the most unusual successes in NIC achievement are found in the extreme cases of Hong Kong and Singapore; the examples of Korea and Taiwan are similar on a larger scale. At the other extreme are the OPEC countries, from which exports of manufactures have not been prominent although these

nations have had the capital to expand industrial development. Less extreme are countries like Malaysia and the Philippines, where some of the other NIC conditions are found but which have lagged relative to others in East Asia in developing manufactures for export given their natural resource-based alternatives. And Argentina, rich in land per capita and with established agricultural exports, is on the margin of NIC status.

These then appear to be five conditions relevant to NIC evolution that may be cited as affecting or characterizing--albeit somewhat loosely--the eight countries selected for discussion. They are not, of course, the full list of conditions affecting the growth of industry in LDCs or the expansion of trade generally. Some additional conditions will be discussed next, to be followed by a brief review of the evolution in the eight countries individually.

Other Factors Bearing on Industrial Exports

For developing countries short on capital and having abundant and low-cost labor, a comparative advantage could be expected from specializing in labor-intensive products and labor-utilizing technologies. A government should therefore be able to increase the competitiveness of its manufactured export sector by controls on labor costs and the collective-bargaining process. Unquestionably this was the basis for some of the NIC successes in export growth; but low labor costs are not sufficient to establish a country's competitiveness. There is a mixed experience in the degrees of labor intensity in manufactured exports from the different NICs. Korea's export experience in the 1960s seems to have been concentrated in labor-intensive manufactures, as was that of Taiwan and Hong Kong. Mexico's trade experience, on the other hand, seems to suggest that its industrial exports are found among products that are somewhat more capital intensive, higher in technology and/or based on mineral resources, rather than in traditional low-technology and labor-intensive processes. Brazil and Argentina seem closer to this pattern; Singapore and India are intermediate.

An important positive factor is the size of an economy. Statistical analysis of individual countries suggests that economies of scale, as well as cumulative experience of one kind or another in production, exporting and related activities, are involved in the successful export of manufactures. Hong Kong and Singapore, of course, started as relatively small economies when they were politically separated from their hinterlands, but they were forced into foreign trade by the absence of alternatives, and they had the physical facilities, skills and experience to become enormously successful exporters.

The role of multinational corporations. Multinational companies can play an important role in transferring AIC manufacturing processes

into the Third World. They are also active in the foreign marketing of LDC manufactures, supplying an expertise that is often needed. Evaluation of the contribution of such companies is difficult, however, because figures from different countries on investment by multinationals are not always comparable. We must consider not only the traditional manufacturing multinationals, but also the big retail and mail-order chains (Sears Roebuck, Great Universal Stores, etc.) which have been creating regional purchasing offices in many of the NICs since the 1960s. The best available figures (Table 3) suggest that the multinationals do play a role, but that it varies greatly by country; the Latin American NIC economies have been more dependent on such investment than the Asian NICs other than Singapore. There is some evidence that the Japanese subsidiaries were particularly likely to be export-oriented rather than import-substituting, followed by U.S. subsidiaries (see Table 4).

TABLE 3

THE SHARE OF MULTINATIONAL FIRMS IN THE EXPORTS OF MANUFACTURES FROM SELECTED UNDERDEVELOPED COUNTRIES (Circa 1972)

Country	*Approximate share*	*Year of estimate*	*Total manufactured exports in 1972: millions of dollars*
Hong Kong	10%	1972	2,635
Taiwan	At least 20%	1971	2,489
South Korea	At least 15%	1971	1,351
India	Approximately 5%	1970	1,320
Singapore	Nearly 70%	1970	893
Brazil	43%	1969	749
Mexico	25—30%	1970	647
Argentina	At least 30%	1969	394
Pakistan	5—10%	1972	380
Colombia	At least 30%	1970	172

Source: Deepak Nayyer's 'Transnational Corporations and Manufactured Exports from Poor Countries' in *Economic Journal* March 1978, Vol 88, p.62.

It would be a mistake to put too much emphasis on the multinational phenomenon for NIC creation. The multinationals may be reacting to changes in the world economy, not creating them. One of the best illustrations of this point is provided by the leading American television manufacturer, Zenith. This company led the way in trying to fight off Japanese imports in the early 1970s. However, in the face of the superior Japanese competition (cheaper labor, superior design and production technology, and some alleged dumping), Zenith could hold out no longer. The firm was forced to move its factory operations into

TABLE 4

USE OF LDC SUBSIDIARIES AS EXPORT PLATFORMS

MNCs based in (1971-2)	*LDC subs (= 100%)*	*Export-oriented subsidiaries (50 per cent or more of sales made for export)*	*Export-oriented subsidiaries as a percentage of all subsidiaries*
US (1976)	2,362	323	14%
Japan	343	92	27%
UK	1,844	24	1%
Germany	645	3	0.5%
Netherlands	310	10	3%
Switzerland	211	3	1%

Source: Compiled by Dr L G Franko from Harvard-CEI Multinational Project data.

both Taiwan and Mexico, where there were already other factories that were not subsidiaries of multinationals.

Exaggeration of the importance of multinational companies leads to neglect of the growing entrepreneurial capabilities within the NICs themselves. In all these countries certain local companies are proving to be effective competitors on world markets. The Koreans have their General Trading Companies, led by Samsung, Hyndai, Daewoo and the Lucky Group, with their spectacular success not only in selling industrial goods but in winning Middle Eastern construction projects in the face of considerable competition from established Western companies. An example from Hong Kong is Conic, a purely Chinese-owned electrical/electronic product manufacturer with a 12,000-strong labor force. In India, Bharat Heavy Electricals Ltd. has won key contracts for its products in the middle East. Another Indian company, Engineers India Limited, is a firm of petrochemical consultants with business in Algeria, Iran, Iraq, Somalia, Sri Lanka, Syria and the United Arab Emirates. In Mexico, Hylsa, a private steel company controlled by the Alfa Group has developed the direct reduction steel process, an important technological breakthrough which it has exported to Brazil, Venezuela, Iran, Iraq, Indonesia and Zambia. In Brazil, Mineracoes Brasileiras Reundias is a major iron-exporting firm, controlled by a Brazilian (though supported by foreign capital). This illustrative list serves as a reminder that the AICs no longer have a monopoly of industrial and marketing skills. It is likely that these NIC companies are the forerunners of an increasing number of NIC-based multinational corporations.

Cultural factors. Cultural factors, almost by definition, play a part in the responses of different peoples to economic problems, challenges and opportunities, although there is room for differences of opinion on their nature or importance. It is probably no accident that the four East Asian NICs which have made the most spectacular advances

from limited resources are inhabited by ethnic Chinese in three cases, and by people of a closely related culture in the case of South Korea. It may also be noted that the Japanese, stemming from the same larger cultural area, have previously exhibited many of the same qualities as the East Asians now following in their path. The other NICs, however, are either not so simply differentiated from their neighbors (in Latin America), or are so unique (India) as to escape classification. One cannot put forward many generalizations about cultures as representing either scientific or eternal truths; yet, cultural factors of some sort do seem to be involved in NIC evolution.

Other factors. Several additional variables have contributed to countries becoming NICs, including natural resource endowment and location. Natural resources condition industrial choices. Proximity to large markets, and usefulness as ports due to being located on major sea routes, are two ways in which location has aided in the development of some of the NICs.

NICs: Emergence--Case By Case

At this point it is useful to examine how these variables and commonalities in different combination have brought about the development of export capability in manufactures in each of the NICs in question.

In the case of the two city-states, Hong Kong and Singapore, the nature of their physical characteristics, location, and history seem to have dovetailed to make them centers of manufactured exports. Indeed, these circumstances almost required that Hong Kong and Singapore engage in trade of manufactures, as there appeared to be little alternative if they were to exist and grow as independent units, a condition forced upon both by vagaries of history. Theodore Geiger writes: "Hong Kong and Singapore are almost totally lacking in natural resources; their arable land can provide only a small portion of their food supply; nor do they have domestic markets large enough to serve as the initial base for industrialization. Hence, their very existence depends on their ability to import, which in turn rests upon their capacity to earn the necessary foreign exchange by exporting goods and services to competitive regional and world markets."

The geographic characteristics were reinforced by the preceding development of Hong Kong and Singapore as entrepots, which in part grew out of their location. In both cases the British had built them up as modern ports, outlets for productive hinterlands from which they became politically separated, located on busy sea lanes. The financial, communications and distributional skills associated with entrepot functions made Hong Kong and Singapore alert to developments in the world economy, which facilitated their transitions in recent years to manufacturing centers focused on export markets. In both, determined efforts and intelligent policies lay behind the growth successes

of the 1960s and 1970s. Hong Kong's *laissez-faire* policies and Singapore's planned development oriented to foreign investment were rather different tactics; both were carried out with firmness and consistency. [See also Development Digest, July 1974, pp. 101-124.]

Both South Korea and Taiwan benefitted from the infrastructure built up during the Japanese occupation of the first half of the 20th century, ending after World War II. In the case of Korea, following the civil war and poor performance of the 1950s, a new government undertook a commitment in the early 1960s to an export-oriented growth strategy. This has led to Korea's rapid industrialization and spectacular performance in manufactured exports. Korea's strategy was predicated on the relatively small size of the domestic market and on its very poor natural resource base. Policymakers became aware that import-substitution industrialization would soon reach an exhaustion point within the limited Korean market, and that significant growth could only be based on an external thrust. A historic commitment was made to an externally-oriented industrial growth objective, and was translated into fiscal, monetary and exchange rate policies which massively increased domestic savings and placed the Korean economy on a competitive footing with the rest of the world. Export incentives were generalized so that comparative advantage could be realized. The policy shift was enduring, due to the nature of the political commitment, so that the element of uncertainty was removed.

Taiwan had much that is similar to Korea in its processes of development, industrialization and export of manufactures. Japanese occupation of Taiwan from 1895 to 1945 provided a substantial injection of investment and human capital and established an infrastructure for modern growth, and the movement of numerous educated Chinese from the mainland to Taiwan after the Second World War furthered this development. A successful period of agricultural development and export growth in the 1950s led rather naturally to and facilitated industrialization and manufactured exports. Policy reforms in 1960 reducing protectionist tariffs, unifying and adjusting the exchange rate, and relaxing exchange controls were of fundamental importance in placing the economy on an outward-looking, export-oriented growth path and on a competitive basis with the rest of the world. Again, similar to Korea, the priority and permanence of these reforms removed elements of uncertainty and engaged other sectors in the endeavor.

Brazil's pattern of industrialization began with import-substitution industrialization in the 1930s and the initial postwar period up to the early 1960s. The new government in 1964 undertook a major shift in economic policy, which at first stressed economic stabilization from 1964 to 1967, then from 1968 on made export-oriented growth, with high priority on manufactured exports, the centerpiece of Brazilian policy. Manufactured exports grew at an average of 25 percent per annum, stimulating Brazilian economic growth which averaged 10 percent per annum for the period up to 1973.

This export-oriented growth phase was in large measure the result of deliberate policy changes in 1968. The Brazilian government shifted to a crawling peg exchange rate, and established an elaborate system of export subsidies, tax exemptions and export credits designed to promote exports. These met with great success, and the 1968-1973 period is now known as the "boom" period in Brazilian economic development. The "boom" peaked in 1973 as productive capacity became fully utilized, and as the oil crisis imposed greater constraints on Brazil due to its dependence on foreign sources for 85 percent of oil requirements. These effects dampened Brazil's export drive and economic growth; there has been substantial recovery, although not all the way back to prior growth rates; then a second oil shock in 1979 further damaged Brazil's situation. But clearly the boom period showed that Brazil has the capacity for dynamic manufactured export growth, and brought Brazil strongly into a leading position among the newly industrializing countries.

Mexico has become an exporter of industrial products on the NIC scale, in part because it has become a successful producer of manufactures for its own markets, but also because of special arrangements with the United States. Mexican industrial policies have generally followed an import-substitution pattern, though not to the extremes found elsewhere. There has not been a concerted export drive, and an overvalued currency inhibited foreign sales during part of the 1960s and early 1970s.

An important portion of current exports of manufactures from Mexico owes a great deal to two special situations relative to the U.S. Nearly half of its industrial exports are products from assembly plants relying in large part on imported inputs from the U.S.; many, though not all of these products are re-exported back to the U.S. under a special provision of the American tariff code which limits duties on re-imports to the value added abroad. About two-thirds of these re-imported products are composed of electronic parts, television and communications equipment. Many of these assembly plants are found in a special border zone established by U.S.-Mexican agreement, and a number of these plants are subsidiaries of U.S. firms. Some 25 percent of Mexican manufactured exports are machinery, much of which is automobile parts and components destined for U.S. markets. Again, special arrangements with the U.S. automobile firms have made this possible. (Note: While it is true that many of these Mexican exports are associated with capital-intensive high-technology industries, the Mexican contribution in such cases may be in relatively labor-intensive segments of the operations.) Future developments in Mexico's trade and industrial growth are certain to be colored by the large new oil exports, the repercussions of which are only now unfolding.

India has become an industrial nation of some consequence since World War II. Its economic plans and policies have tended toward pro-

tectionist import substitution, but there have also been export incentives amid the complex regulations. India's low labor costs have made possible the export of a portion of its growing textile industry output, and traditional jute exports have continued. Its heavy industries have been the object of state encouragement, and in some cases a sufficiently high level of quality at competitive cost has been attained to enable export sales in various machinery categories. In recent years financial policies have been liberalized, resulting in somewhat stronger incentives to export. Overall, the rates of growth have been slow relative to those in the other NICs discussed here, but there is the definite potential for sustained and sizable increases in the future.

Argentina gets into the NIC category by virtue of the size of its industrial exports in the mid-1970s, but is not really a "newly industrializing" country. Its period of most rapid growth was prior to 1930; its major period of industrialization came in the 1930s and 1940s as a defensive reaction to the depression in agricultural earnings and the subsequent wartime shortages. This also occurred in Brazil and Mexico; but in Argentina's case the postwar period has been one of political instability and inability to achieve as consistent a rate of progress as the other two nations beyond the relatively high per capita income already attained. Nevertheless, the nation was able to effect a brisk increase in industrial exports between the mid-1960s and 1970s under the strong stimulus of new tax and exchange rate incentives. Some of these exports were processed agricultural products, but others were machinery and automotive products, many going to other Latin American countries with some help from LAFTA (Latin American Free Trade Area) arrangements. Subsidiaries of foreign firms were active in this development, but indigenous enterprise participated too. The 1974-75 period brought a set-back. The new government since 1976 has been moving toward economic stability, and total exports have grown but mostly in agricultural products; an overvalued exchange rate, together with Argentina's high-cost labor have been inhibiting the export of manufactures. The near term outlook depends on the joint incentive results of various, sometimes contradictory, taxes and exchange controls.

Two major patterns of NIC formation emerge from this review: the small economy of limited resources intensely mobilized for rapid achievement; and the larger, more diversified economy which achieves NIC status at a more leisurely pace as a byproduct of an industrialization program largely guided by import-substitution policies. Brazil moved from the second into the first category--at least in the intensity of its growth thrust. Other developing countries have also shifted from inward-looking to more export-oriented policies during the late 1960s and 1970s, but none with a success on the scale of Brazil.

Potential NICs

To round out this analysis of NICs in the developing world, it is useful to consider briefly some of the countries which have approached but have not so far attained this designation--recognizing, of course, that the borderline for using the NIC label is an arbitrary one. Some of the most likely candidates for the next tier of future NICs would include Malaysia, the Philippines, Thailand and Pakistan in Asia, as well as such "sleeping giants" as China and Indonesia: Colombia, Chile, and Peru in Latin America; and Algeria, Egypt, Turkey and Iran in the Middle East--with Saudi Arabia as a specialized case. (Again, Europe is omitted from consideration.)

Malaysia, despite successes in export of rubber, tin and now oil, is also moving into a diversity of industrial markets; its policies are reasonably favorable to exports. Pakistan has developed textile markets plus a few specialties. The Philippines and Thailand, traditional exporters of sugar and timber, and rice and timber respectively, have been more inward-looking in policy, and have been less fortunate than Malaysia in maintaining political stability; this last would be true in Pakistan as well. In Indonesia, the traditional exports of rubber and timber, etc., now massively augmented by oil, have so far overshadowed any potential manufacturing for export. As for mainland China, while its industries have grown on a very large scale they have been almost entirely designed to supply the growing domestic needs, and their international competitive qualities are untested except in a few consumer goods categories. The potential for large scale export of manufactures appears to exist for the longer run, and some shifts toward a more outward-looking policy have occurred recently; but it will take further policy reorientation and a number of years before this potential can be realized.

Of the Latin American candidates, the closest to NIC status may be Colombia, where industrial growth has been appreciable but exports have been dominated by agricultural products. Peru, following a drastic shift from an import-substitution policy to an export-oriented policy in the mid-1970s, recently increased manufactured exports more than eight-fold--from $105 million in 1975 to an estimated $850 million in 1980. Increased textile exports account for the majority of this increment, but there have also been increases in the export of cement, metal products and processed agricultural goods. Chile, with a smaller population, is showing signs of increasing outward orientation and industrial growth, but is not as fully mobilized for export as the Far East NICs. Venezuela, with its oil resources, is under no current pressure to export manufactures.

The last general observation would apply to several of the Middle Eastern countries which have displayed recent growth in industrial production. Iran, which has had a considerable investment in factories,

seems unlikely to get stably organized soon, and in any case can fall back on its oil to earn foreign exchange. If Iran lost its oil-exporting capacity, it might be forced into a strategy emphasizing manufacturing, but the internal situation is very unpredictable and Iran is an unlikely NIC candidate in the 1980s. Algeria, too, can fall back on its oil exports, but has been building an industrial capacity which may eventuate in exports in time. Turkey and Egypt have no oil exports to count on; both have moved ahead with industrial development, especially Turkey, and for longer than the oil exporters. But in neither case are policies sufficiently outward looking, nor are efficiency levels such that they could ensure success in the export of manufactures without greater policy change. Lastly, Saudi Arabia with its vast oil sales has no current need of industrial exports; but it is building some new industrial enclaves for the future, with emphasis on petrochemicals, and can afford to install them quite rapidly. How this experiment will turn out is not yet clear.

In sum, the countries of the Third World that have not yet become significant industrial exporters include a few (e.g., Malaysia, Colombia) where the potential may be close to realization; but in most cases the absence of one or more of the five conditions listed above is holding them back. One of the conditions applying to all countries, the growth rate in the world economy, is likely to be somewhat less favorable to would-be exporters of manufactures in the 1980s than in the 1960s and early 1970s. Probabilities for political stability and export-oriented policies are difficult to predict, and the 1980s could be a difficult period in this respect too. The extent of protectionism surrounding the larger OECD markets is similarly uncertain.

Table 5 supplies basic statistics on NICs and near-NICs.

Disadvantage of NIC Status

It should be kept in mind that the NICs, as a result of success in industrial exports, stand out from other LDCs in the following ways:

1. NICs are more dependent on world markets than are other LDCs as a result of their commercial successes. This makes them more vulnerable to fluctuations in these markets. (This may be less true in the case of India.)

2. NICs have been affected on a larger scale by OPEC price moves than have other LDCs. NICs are more dependent on imports generally to maintain growth, and this is especially true of oil imports. (Mexico is an obvious exception with respect to oil.)

3. NICs have been the heaviest borrowers from banks among LDCs since 1973 because of efforts to obtain high-cost

TABLE 5

BASIC INDICATORS

BASIC DEVELOPMENT INDICATORS OF NICs AND NEAR NICs

Country	Population (millions) Mid-1978	Area Thousands of Sq. Km.)	GNP/Capita ($) 1978	GNP/Capita Avg. Annual Growth (%) 1960-78	Avg. Annual Rate of Inflation (%) 1960-70	Avg. Annual Rate of Inflation (%) 1970-78	Adult Literacy Rate (%) 1975	Life Expectancy at Birth (Years) 1978
NICs								
India	643.9	3,288	180	1.4	7.1	8.2	36	51
Hong Kong	4.6	1	3,040	6.5	2.3	7.7	90	72
Singapore	2.3	1	3,290	7.4	1.1	6.1	75	70
Rep. of Korea	36.6	99	1,160	6.9	17.5	19.3	93	63
Taiwan	17.1	36	1,400	6.6	4.1	10.3	82	72
Mexico	65.4	1,973	1,290	2.7	3.5	17.5	76	65
Brazil	119.5	8,512	1,570	4.9	46.1	30.3	76	62
Argentina	26.4	2,767	1,910	2.6	21.8	120.4	94	71
Near NICs								
Thailand	44.5	514	490	4.6	1.9	9.1	84	61
Philippines	45.6	300	510	2.6	5.8	13.4	87	60
Colombia	25.6	1,139	850	3.0	11.9	21.7	81	62
Chile	10.7	757	1,410	1.0	32.9	242.6	88	67
Malaysia	13.3	330	1,090	3.9	-0.3	7.2	60	67
China	952.2	9,597	230	3.7	--	--	--	70
Pakistan	77.3	804	230	2.8	3.3	14.6	21	52
Peru	16.8	1,285	740	2.0	9.9	22.2	72	56
Algeria	17.6	2,382	1,260	2.3	2.3	13.4	37	56
Eygpt	39.9	1,001	390	3.3	2.7	7.0	44	54
Turkey	43.1	781	1,200	4.0	5.6	21.5	60	61
Indonesia	136.0	2,027	360	4.1	--	20.0	62	47
Iran	35.8	1,648	2,160	7.9	-0.5	23.7	50	52
Saudi Arabia	8.2	2,150	7,690	9.7	--	28.4	--	53

Source: World Development Report, 1980. The World Bank, 1980, pp. 110-111.

oil, and to maintain their fast growth rates in the face of sluggish markets for their exports. Therefore, the NICs have built up unprecedented large debts. But they are not generally the chief risk-problem countries from the banks' standpoint, due to their unusual exchange earning capabilities.

Impact of NICs on the Advanced Industrial Countries (AICs)

Questions now arise as to how the emergence of NICs affects the economies of the more established industrialized countries. What AIC manufacturing sectors have been most affected by NIC competition? How has improved economic performance by NICs affected their role as AIC customers? Do these advances in NIC commercial success constitute a threat to AIC markets? These impacts, as seen from within the AIC economies, may have important consequences for the NICs themselves, as well as for potential future NICs.

Export sectors. LDC exports of manufactures have been concentrated among a few exporting countries (i.e., NICs) as noted earlier; they also have been concentrated in a relatively few industries. In 1974, over one-half of LDC exports of manufactures to all developed countries were centered in just three industrial sectors: textiles, clothing, and electronics and electrical machinery (see Table 6). LDC exports

TABLE 6

PRODUCT COMPOSITION OF DEVELOPING-COUNTRIES' EXPORTS TO DEVELOPED COUNTRIES AND TO OTHER DEVELOPING COUNTRIES, 1974

Product Group	To Developed Countries	To Other Developing Countries	Percent Going to Developed Countries[b]
Textiles	14.5%	18.1%	54.3%
Clothing	21.0	5.5	85.9
Electronics and electrical machinery	15.7	6.0	82.3
Other machinery and transport equipment	3.0	20.9	21.2
Chemicals	9.6	15.5	51.5
Iron and steel	4.7	6.2	57.9
Other manufactures	31.4	26.8	67.6
Total	100.0	100.0	63.4

[a]Yugoslavia is counted here as a developed country.

[b]Taking into account exports (not shown) to centrally planned economies.

Sources: U.N., *Monthly Bulletin of Statistics* (May 1977); and Donald B. Keesing, "World Trade and Output of Manufactures: Structural Trends and Developing Countries' Exports" (Washington, D.C.: World Bank, 1979), p. 33.

to the United States show only slightly less concentration: in 1976, the same three sectors (including footwear with clothing) accounted for 49 percent of the $15.4 billion of total U.S. imports of manufactures from LDCs. No less than 75 percent of all U.S. imports of manufactures from LDCs in 1976 were accounted for by these sectors plus leather goods, nonferrous metals and miscellaneous manufactures, such as jewelry.

In at least one of these sectors of noteworthy OECD imports from LDCs, textiles (i.e., fibers and fabric, excluding clothing), import penetration was more than compensated for by increasing exports. Throughout the latter 1970s the United States had a slight positive balance of trade in textiles while the EC and Japan had still more favorable balances in textiles (see Table 7). Clothing, however, was quite a different matter: the United States and European countries, and to a lesser extent Japan, had large and growing negative trade balances in clothing over the same period. Of the major OECD countries, only Italy and France had positive trade balances in clothing.

TABLE 7

NET TRADE IN TEXTILES AND CLOTHING IN SELECTED COUNTRIES, 1973, 1976 AND 1977

(Billions of dollars)

	Textiles			Clothing		
Country	1973	1976	1977	1973	1976	1977
U.S.	- $0.36	$0.32	$0.17	- $1.88	- $3.05	- $3.45
EC	1.97	1.47	1.70	- 0.89	- 2.75	- 2.68
France	0.29	- 0.27	- 0.13	0.45	0.13	0.19
Germany	0.30	0.30	- 0.07	- 1.63	- 2.72	- 2.99
Italy	0.62	0.80	1.15	1.11	1.85	2.24
Japan	1.32	2.39	2.84	- 0.20	- 0.37	- 0.41

Source: GATT, *International Trade, 1977/1978* (Geneva, 1978), p. 59.

Import penetration relative to markets. The total values for imports of manufactures from all LDCs, including NICs, has been less than one percent of gross domestic product for most OECD countries, and in no case over 2 percent. Thus, despite the rapid recent growth in such imports, the overall job displacement impact on AICs is so far small relative to shifts in employment due to domestic cyclical swings or technological changes.

In a few industries, the effects have been more important. Generally these are among the most labor-intensive activities--clothing, footwear, leather goods, certain electrical products where hand assembly is

important. Much of the labor employed in these industries tends to be relatively unskilled and immobile, and therefore hard to absorb in other industries even in periods of expansion. Many of these workers are elderly; many live in relatively stagnant regions of their countries; many work for vulnerable small firms. For all these reasons, the job losses hit politically sensitive nerves, and rouse demands for protection against imports. The important question, however, is to what extent job losses in affected sectors resulted from imports (from NICs or elsewhere) rather than from other causes. We will not attempt to analyze causes here; suffice it to say that a number of causes other than imports can be found, and that these have had substantial impact.

LDCs as customers. The NICs may represent a potential threat to segments of some U.S. and European industries, but they offer growth opportunities for others. From 1970 through 1976 the NICs took more than six percent of total OECD exports of manufactured goods, amounting to $465 billion annually. For all non-oil LDCs the total reached 14 percent of OECD manufactures in 1976. As rapidly as AIC imports of LDC manufactures grew during the early 1970s, it is clear that advanced-country exports of manufactures to LDCs grew even faster (see Table 8). The growing incomes of LDCs, especially in the NICs, were increasing their demands for many of the AIC products.

TABLE 8

THE RICH WORLD'S TRADE IN MANUFACTURES WITH THE POOR, 1972, 1974, 1976, AND 1977

(Billions of dollars)

	United States's			European Community's			Japan's		
	Exports	Imports	Balance	Exports	Imports	Balance	Exports	Imports	Balance
1972									
Oil LDCs	$ 2.0	$ 0.1	$ 1.9	$ 5.0	$ 0.3	$ 4.7	$ 1.8	nil	$ 1.8
Nonoil LDCs	7.6	6.1	1.5	12.8	4.2	8.6	7.1	$ 1.2	6.0
Total LDCs	9.6	6.2	3.4	17.8	4.6	13.3	8.9	1.2	7.7
1974									
Oil LDCs	4.3	0.1	4.2	11.8	0.6	11.2	5.2	0.1	5.1
Nonoil LDCs	16.4	10.8	5.6	23.5	8.9	14.6	15.2	3.4	11.8
Total LDCs	20.7	10.9	9.8	35.3	9.5	25.8	20.4	3.5	16.9
1976									
Oil LDCs	10.0	0.1	9.8	23.3	0.6	22.7	9.0	0.1	8.9
Nonoil LDCs	18.5	14.8	3.7	25.7	11.1	14.7	16.3	3.5	12.9
Total LDCs	28.4	15.0	13.4	49.0	11.7	37.3	25.4	3.6	21.8
1977									
Oil LDCs	10.6	0.2	10.4	29.7	0.8	28.9	11.6	0.1	11.5
Nonoil LDCs	19.1	16.9	2.1	30.4	13.1	17.3	20.5	3.7	16.8
Total LDCs	29.6	17.1	12.5	60.1	13.9	46.2	32.1	3.8	28.3

Note: "Balance" figures may not equal exports minus imports due to rounding.
Sources: GATT, *International Trade*, various issues, and discussions with GATT officials.

In the late 1970s these trends slackened somewhat. Policymakers in the NICs chose to reduce growth, and to restrict imports and promote exports even more than before. Faced with the oil price increase of late 1973, the industrializing LDCs had suddenly had a balance-of-payments constraint to growth. During 1974 and 1975, however, they were able to borrow heavily from the private banks and the Eurodollar markets where OPEC had placed its surplus funds. In 1976 and 1977, fears of over-extension led private banks gradually to reduce their net lending to nonoil LDCs: U.S. Treasury figures indicate a decline from $11 billion to $5 billion between 1976 and 1977. Simultaneously, countries such as Brazil followed advice to "tighten their belts," and initiated a policy of import reduction by levying large new tariffs or by tightening quantitative or government purchasing restrictions on top of already existing high-tariff protective structures. Because of the relatively short term of many of the debts incurred by the NICs, these countries attempted to accelerate the already rapid growth of their exports of manufactures in order to earn the foreign exchange with which to service and pay back these loans. Export subsidies, and "performance requirements" on approval of new investments (requiring that they achieve minimum export levels) proliferated.

From the point of view of the developed countries, it might be asserted that the NICs have succeeded all too well in coping with the difficult economic management problem handed to them by the OPEC oil price revolution, even though Brazil and Mexico continue to have debt-service-to-export ratios which are considered very high by historical standards. The advanced countries' problems should be kept in perspective, however. To summarize:

1. LDC exports of manufactures have been disruptive only in a few specific sectors, due to their concentration by product group.

2. The impact of LDC penetration in the OECD countries' markets for textiles, clothing and electronics appears to have been small relative to the impact of such domestic phenomena as inadequate investment in physical and human capital in the advanced economies, and the penetration of imports from Japan in other OECD markets for autos and steel.

3. The deterioration in advanced-country trade surpluses with the NICs after 1977 was, in large part, due to a forced pace of increase in NIC exports, accompanied by the NICs' choices of policies favoring lower growth and restriction on imports, in reaction to the oil price shock. The strength of that reaction can be traced primarily to the short- and medium-term maturity structure of the NICs' debt incurred in world financial markets as they attempted to cope with that shock.

The NICs in the 1980s

Two rather different views of the NIC phenomenon can be recognized. One is that there is a one-way historical process at work, common to all countries in their economic development, which brings about changes in comparative advantage over time; this leads to shifts in the composition of output, and eventually to changes in the pattern of exports. In this view, the emergence of the NICs is part of a changing world economic structure corresponding to shifts in the international division of labor among countries. These changes are seen as a generalized historical movement, in which the most advanced industrial countries vacate intermediate sectors in industrial production with the more advanced developing countries moving into these sectors. These advanced developing countries in turn move labor away from the more basic industrial sectors in which the next tier of developing countries is engaged. This view, then, suggests that the present necessity for AICs to adjust to growing NIC competition is a tip-of-the-iceberg kind of problem because the historical process of industrialization will continue to spread, and the number and growth dimensions of new NICs will continue to increase.

The other view sees the emergence of NICs in the past decade or so as a process of concentration of industrial capacity in particular countries characterized by special circumstances that made high-volume, dynamic expansion of manufactured exports feasible. It is also a process dependent on a rapid growth in world trade, without which new NICs could not emerge. This view suggests that the development of substantial industrial capacity of significance in the global structure of production and exports occurs in particular circumstances which lead to a major thrust toward the world market in manufactures. This process is essentially concentrated in a limited number of countries in which the necessary conditions are present, rather than found in a wide variety of countries. The implication of this view for the future is that the need for AIC adjustment to NICs as it emerged in the 1970s may have been greater than is likely in the 1980s in terms of the number of newly industrializing countries capable of playing a global role in world trade in manufactures.

Neither of these views of the issue has an exclusive hold on the truth. To a very considerable extent, both the implied processes may be going on simultaneously. Nevertheless, it is useful to highlight the differentiation of these two views, so that in looking to the future judgments can be reached as to the relative weight of the various forces affecting the shape of LDC-OECD trade relations in manufactures in the 1980s.

To a certain extent, the relative weight that one would assign to the forces moving toward country concentration as compared to those toward country spread would be determined by the degree to which one

is taking a global perspective. The term NIC is by definition applied to a country of significance in world markets in terms of volume and growth in total industrial exports. Conversely, to the degree to which one is taking a sectoral perspective, one is concerned with disruption and displacement of particular industries derived from the cumulative penetration of foreign imports from whatever source. There is also the question of how one foresees the rates of growth in OECD countries through the 1980s.

The forces working toward concentration of industrial capacity in a limited number of countries appear now (as of 1981) to be more important in defining industrial trade adjustment between the OECD and developing countries than are the more generalized historical forces for industrial spread. If this view predominates among OECD policymakers, the danger of their imposing new trade restrictions during the 1980s will be lessened. However, this prospect also depends on the economic growth that will prevail in 1980s. It is easier to accept and adapt to new foreign competition when growth is proceeding well than in a recession; imports look far more threatening when total jobs and profits are being reduced.

Another tier? As Table 9 indicates, the 1976 magnitude of manufactured exports from the "next tier" of developing countries was quite small relative to that of the eight NICs. For example, manufactured exports from the five countries in the next tier in East Asia, which includes some of the most promising newcomers--Malaysia, Thailand, the Philippines, and Indonesia--together comprised less than 10 percent of the volume from the East Asian NICs in 1976. The twenty-two countries from all regions in the next tier, taken together, constitute less than twenty percent of total NIC manufactured exports in 1976. It would take a growth rate of 20 percent a year over a nine year period in these countries to attain the value of manufactured exports in 1985 that the eight NICs achieved in 1976. World trade expansion will probably slow in the 1980s, and it is unlikely that first tier NIC manufactured exports will in fact grow more slowly than exports from the next tier; even if they did, the first tier NICs would still remain the predominant exporters among developing countries in 1985.

The dynamism of the expansion of exports from the leading industrial sectors in the NICs during 1965-75 was generated, in our view, by a combination of circumstances and conditions which dovetailed in an unusual way to bring about a major thrust by these countries toward world markets. In each case this surge in manufactured exports was also the result of a highly deliberate national effort. The key elements in the emergence of the NICs--particularly the four East Asian NICs and Brazil--seem to have been political and social in character, leading to a societal commitment to an export-oriented growth strategy based on manufacturing for foreign markets.

TABLE 9

MANUFACTURED EXPORTS FROM THE NICs AND THE NEXT TIER OF DEVELOPING COUNTRIES: 1976

(U.S. Dollars)

EAST ASIA						
NICs:	Hong Kong	6,480[a]				
	Korea	6,747				
	Taiwan	6,921				
	Singapore	2,920	23,068 Total			
NEXT TIER:	Malaysia	799				
	Thailand	511				
	Philippines	397				
	Macau	207				
	Indonesia	119	2,033 Total			
LATIN AMERICA						
NICs:	Brazil	2,332				
	Mexico	2.327				
	Argentina	976	5,635 Total			
					(1975)	
NEXT TIER:	Jamaica	345		Guatemala	155	
	Colombia	384		El Salvador	200[b]	
	Venezuela	150[b]		Dominican		
	Trinidad &			Republic	120	
	Tobago	122		Costa Rica	119	
	Uruguay	170		Chile	150[b]	
				+20%	149	2,064 Total
AFRICA						
NEXT TIER:	Morocco	202				
	Tunisia	203				
	Bahrain	200				
	Senegal	200[b]				
	Ivory Coast	134	939 Total			
SOUTH ASIA						
NICs:	India	2,803	2,803 Total			
NEXT TIER:	Pakistan	677				
	Bangladesh	220	987 Total			
NICs:			31,506 TOTAL			
NEXT TIER:			5,933 TOTAL			

Source: Donald B. Keesing, World Trade and Output of Manufactures: Structural Trends and Developing Country Exports, World Bank, January, 1979, Annex B

a/Excludes re-exports. b/Estimates based on figures in previous years.

Conclusions. These trends suggest that the dovetailing of favorable economic conditions with externally-oriented political and social forces is less likely to be a generalized phenomenon over, say, twenty or more countries than to be limited to a few unusual countries. This is not to say that export growth is not possible for a number of countries, but that only a few can expect to expand at a Brazilian-Korean pace. Secondly, the trends suggest that the *internal* history of individual countries is more powerful in generating the kind of national commitment required to become a NIC than are the external historical forces behind the generalized spread of industrialization globally. Thirdly, the NIC formation process will need growing world markets, along with high employment in AICs and willingness to accomodate required structural change; and these will not be as prevalent in the 1980s as in the 1970s.

Finally, the rise of manufactured exports from developing countries has a self-reinforcing nature in the process itself. These reinforcing qualities would appear to operate both internally and externally. Internally, the managerial, marketing, design and entrepreneurship qualities needed for successful exports of manufactures are of the learning-by-doing variety, and would therefore tend to be spun off from one set of activities to another. Once Korean manufacturers, for example, learned how to penetrate the U.S. market for electronic calculators in a major way, they could move on to color television sets with greater ease than could other countries who have been marginal exporters. The importance of these qualitative capabilities to operate cumulatively has to be a factor enhancing the tendency for country concentration in manufactured exports.

On the external side, foreign investors, international banks and multinational corporations tend to gravitate to countries with bright economic prospects. It is a feature of creditworthiness considerations that favorable foreign financial flows go to countries already doing well, permitting them to do better, while other countries, needing the external resources more, have difficulty attracting foreign commercial funds. Hence, both internal and external factors tend to operate in a way which concentrates resources, creating a dynamic climate in which success breeds success. Obviously this does not go on indefinitely without change, but it is a powerful short run force.

The implications of these points for the future are that the NICs are likely to keep their leading positions in the first half of the 1980s at least. It is possible, however, that a second and smaller wave, composed of Malaysia, Colombia, Chile and possibly the Philippines, could emerge toward the end of the decade. China could well become a real Third World competitor in the 1980s depending on the evolution of its policy orientation, although indications so far don't point to a development of this status much before the last decade of this century.

Another possibility for the 1980s, one on which past experience provides less guidance, is that the growth dynamic which has so far depended heavily on AIC markets may increasingly operate in the trade of developing countries with one another. The NICs will, obviously, have a leading role in this development, insofar as it occurs. To pursue this direction of growth would require some reorientation of policies on the part of both the NICs and their potential trading partners, so that the potentials may be realized and expanded. Just how to do this may become a major challenge of the 1980s.

[Adapted from Chapter 1 of The Newly Industrializing Countries in the World Economy, Report of the National Planning Association for its British North American Committee, publication forthcoming 1981.]


NUTRITION

CHILD DRINKING MILK IN HONDURAS. (PHOTO: FAO)

Malnutrition: Major Cause of Disease and Death in Third World Children

Margaret Cameron and Yngve Hofvander

[Certain maladies are caused directly by nutrient deficiencies. Others are the indirect result of malnourishment; the body is weakened and less able to resist disease, infection and parasite infestation. This article deals with both of these types of malnutrition, and with the preventative measures that might be taken.]

Most developing countries have a high percentage of young people--almost half the population is less than 15 years of age, compared with about one-quarter in industrialized countries--and some 15 to 20 percent of the total population is under the age of five. However, more than 50 percent of the total deaths occur in children under five years of age, compared to less than 20 percent in Europe and North America. The infant mortality rate--that is, the number of deaths that take place during the first year of life per 1,000 live births--usually ranges between 100 and 200 per 1,000 in developing countries, which is nearly 10 times higher than in industrialized countries. For the ages from one to four years, mortality ranges from 30 to 50 times higher than in Europe and North America.

Pattern of Diseases

The diseases affecting infants and young children in developing countries are, to a great extent, related to age, environment, and feeding pattern. In the newborn, illnesses often are connected with premature birth, low birth weight, or a complicated delivery that

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causes birth injuries or breathing difficulties. Often it is difficult for a prematurely-born infant or an infant with retarded fetal growth to suck the breast, maintain body temperature, mobilize sufficient sugar for energy, and resist infections, particularly in an unhygienic home environment. Such infants may not survive.

The newborn is extremely susceptible to infections from both the mother's birth canal and the environment. Breast milk contains specific antibodies that protect the infant from these dangers during the first days and weeks of life. Any other food given at this time could be hazardous. Such foods as butter, cow's milk by bottle, and various other mixtures that sometimes are thought of as strengtheners often will cause disease.

In the postneonatal period--that is, after the first month--the baby's health continues to depend on unsupplemented breast-feeding, provided, of course, that the mother can supply enough of it. If supplementary feeding, particularly bottled cow's milk, is started during the first few months, diarrhea will most certainly appear, and other infections and infestations will be more prevalent. Serious lung infections include whooping cough, tuberculosis, and those that follow and complicate measles. Measles, which can have serious effects for all children, is particularly dangerous for those in developing countries because it affects preschool children who may be malnourished to a greater or lesser degree. This group's death rate from the disease is about 5 to 7 percent. Malaria is another threat; in areas where that disease is endemic, it starts to affect young children at a few months of age.

From a few months of age, intestinal worms and parasites start to inhabit the intestines of infants, and some may affect their health adversely. For instance, hookworm causes anemia and *Giardia lamblia*, a parasite, causes diarrhea and affects the ability to absorb nutrients from food. Thus, many different diseases affect the health of infants and young children in developing countries; but the diarrheal diseases and malnutrition are most important from a public health point of view.

Diarrheal Disease

Diarrheal disease is the greatest killer of infants and young children. Studies made in India and Guatemala showed that the incidence of diarrhea seems to increase rapidly soon after infants are given food in addition to breast milk; the incidence is particularly high in the second year of life ("weanling diarrhea"). The same studies also revealed that diarrhea is more common in undernourished than in normal children, and that the more severe the undernutrition the more frequent and severe are the diarrheal episodes. This is

often the condition if sanitation is poor. On the other hand, it has been shown that the incidence of diarrheal disease in a community decreases sharply when food supplements are given.

In severely malnourished children, damages in the intestinal mucosa (the mucous membrane lining the inner surfaces of the intestine) impair food digestion and absorption. Malnourished children who suffer repeated episodes of diarrhea may also have become intolerant to lactose, or milk sugar, due to a lack of the enzyme lactase, and so react badly to a milk diet. Infections outside the intestines--pneumonia, ear infection, or malaria--may also lead to vomiting and loose stools, although usually these symptoms are not as severe as those from true intestinal infections. In only about 20 percent of all diarrheas is it possible to identify a specific causative agent, such as bacteria, a virus, or a parasite. Attacks of diarrhea can also be caused by an intake of too much indigestible food. Some foods, such as beans, may be poorly prepared and cooked; hot foods, such as chillies, may cause irritation in the intestines, as can some traditional herbal medicines.

Every patient with watery diarrhea has some dehydration and needs replacement fluid. Dehydration may be mild, moderate, or severe. Patients with milk dehydration appear almost normal, even though they might have lost 25-50 ml/kg body weight. The young child with severe dehydration is likely to lose 100 ml/kg body weight or even more. As fluid is lost, signs of dehydration (e.g., thirst, increased pulse rate, sunken eyes, inability to pass urine, etc.) develop rapidly and so should be treated quickly. Unless it is caught while the symptoms are still mild, it will worsen and become more difficult to manage.

Thirst is the only early sign of dehydration. Infants show their thirst by crying and being eager to drink any fluid given to them. When dehydration is mild, patients may first appear normal, but, as dehydration increases, they become restless and weak. Finally, they become dazed, then unconscious, their bodies become limp and their hands and feet become cold. This condition is called shock. Loss of body fluids cause the tissues behind the eyes to shrink, so the eyes appear sunken and dry. In infants, the soft spot on the top of the head sinks. The pulse rate increases and the strength of each beat weakens.

The most important treatment for diarrhea is the following: 1) *Rehydration*--Replace the water and salts lost in the stools. This treatment should be completed within six hours. 2) *Sustenance*--Continue to replace losses of water and salts so dehydration does not return. Start feeding the usual diet, whether breast milk, cereals, or other weaning foods. Treat other infections or complications.

Give drugs if, and only if, needed. This treatment should continue until the diarrhea stops.

Starvation is especially harmful during an illness such as diarrhea. Breast-feeding should continue if the child is on breast milk, but other food should not be given until the child is able to eat. This period, however, should be as short as possible and not last more than six to 24 hours. Many young children with diarrhea are already poorly nourished, and loose stools may in some cases be, in part, the result of malnutrition. If the infant is not able to suckle, it is advisable to discontinue breast-feeding for a short period--a day or so--during which time the mother's milk should be extracted, the infant should be returned to the breast as soon as possible. In partly breast-fed infants, the supplementary foods, like cow's milk or a gruel, should be stopped temporarily and replaced by rehydration fluids.

After a short period of intestinal rest, small, frequent feedings should be started. These may consist of diluted boiled milk, preferably skimmed, or soured milk, prepared either locally or commercially. The feedings should be increased in amounts and strength over the next day or two, and followed by such foods as gruel, porridge, or mashed bananas. In the most uncomplicated cases, the child should be back on a normal diet in three to four days. Some children may have successive diarrhea attacks when fed cow's milk especially in dried, skimmed-powder form. For such children, cow's milk should be avoided if other foods are available as sources of energy and protein but, if it must be given, quantities should be limited to about 150 ml, diluted with clean boiled water or glucose-salt solution, given every four hours.

It is important to follow up on undernourished children who have recovered from an acute attack of diarrhea. As long as they remain malnourished they are at risk for more of the disorder, as well as from infection, further malnutrition, and death. Drugs are not usually needed in mild or moderate cases of diarrhea, but one of the less-absorbable sulfa drugs, such as sulfaguanidine, may be used. In severe cases of dehydration, administration of fluid is much more important than drug therapy. The decision to use drugs should be left to the doctor or the medical assistant.

Deficiencies in Energy, Protein, and Other Nutrients

Certain vitamin--and mineral--deficiency diseases occur with varying frequency in infants and small children. These include avitaminosis A, rickets, and iron-deficiency anemia. The incidence varies greatly from place to place, depending upon both the local dietary pattern and cultural factors. In some countries, eye damage resulting

from vitamin-A deficiency is reported to occur frequently. If this is a problem, an injection of vitamin A should be given to the child to help prevent blindness. The vitamin-A deficiency disease xerophthalmia, which may lead to blindness, may be prevalent despite the presence in the area of vitamin A-containing foods that are not eaten in the normal meals because the inhabitants of the region do not know their value (see article on leaves below).

Protein-energy malnutrition (PEM) is the most common form, and is seen during the transitional period of weaning. It is the world's principal public health problem and, if unchecked, will leave many children permanently handicapped both physically and mentally. The nutritional status of young children runs downward from normal, to mild, to moderate protein-energy malnutrition, with severe syndromes, such as kwashiorkor and nutritional marasmus at the bottom. Some of the relevant symptoms are illustrated in Figures 1 to 6. In developing countries, the majority of young children pass through either a mild, moderate, or severe form of PEM during the weaning, or transitional period. The desirable rate of weight increase, which may represent the general development, is illustrated in Figure 1. During the first few months, the infant develops well, provided there is a good flow of breast milk. From four to six months of age, or even earlier, growth falters and the weight curve flattens. This is due to the combined effect of inadequate diet and infection. Some infants develop a more severe type of malnutrition, which may be a nutritional marasmus, kwashiorkor, or some intermediate form. The infants who get sufficient energy and nutrients in their food have few infections and develop well.

Typical marasmus is seen in the infant in Figure 2. The sufferer is usually less than one year but may be older, has severely retarded growth, and a low weight for age, usually below 60 percent of the standard weight. The muscles are markedly wasted. They are "flabby," which is often best felt on the thighs and buttocks, where the muscles should be thick and strong. Because the subcutaneous fat (fat under the skin) is poor or almost absent, the skin is loose and seems to be too big for the body. Nearly always, such an infant has an "old man's face" or a "monkey face." A marasmic patient does not have haircolor changes and there is no edema (an excessive accumulation of fluid in the tissue; bloating) as is the case with kwashiorkor. In addition, there may be associated signs of various vitamin deficiencies, depending on the local dietary pattern.

A child with typical kwashiorkor is shown in Figure 3. This disease usually occurs in children one to three years of age. Growth is retarded and muscles are wasted and flabby, but the subcutaneous fat usually is not as poor as in marasmic children. Some "sugar babies" may even be fat, indicating a sufficient or more-than-

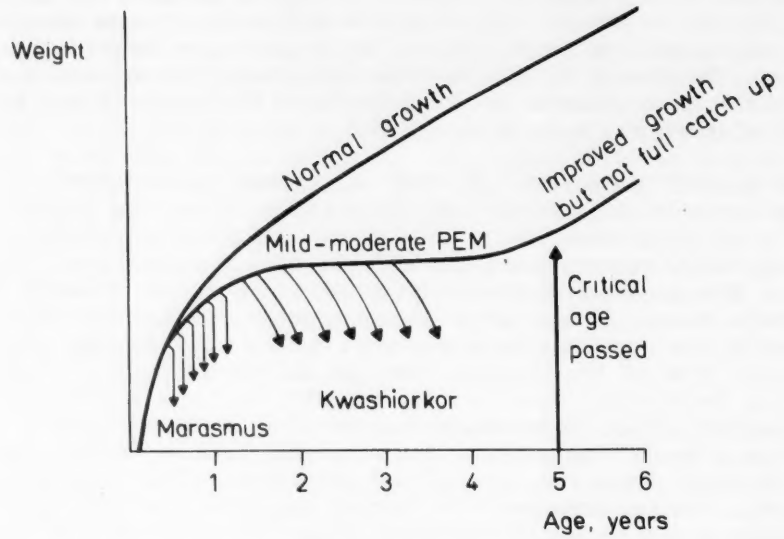

Figure 1. Effect of protein-energy malnutrition (PEM) on growth.

Figure 2. One-year-old child with typical nutritional marasmus.

Figure 3. A child with typical kwashiorkor.

Figure 4. A child with moderate PEM. Note the wasting of muscles, which is expressed by muscular weakness.

Figure 5. A child with less than 70% weight for age.

Figure 6. Same child having recovered, now with more than 90% weight for age.

sufficient energy intake. Children with kwashiorkor always have edema, mainly on the feet and lower legs, and they are miserable and apathetic. Because they are not hungry, they are difficult to feed. Often the hair changes color, sometimes even to gray; it becomes sparse, straight, and can be pulled out easily. The children appear "moon-faced," their skin is pale, and often they are anemic. In severe cases, a "flaky-paint" rash may be seen, particularly around the large joints. Intermediate cases of PEM are not uncommon; and children suffering from marasmic kwashiorkor (deficiency of both protein and calories) are often seen.

Children who are improperly fed during the weaning period have a mild or moderate form of malnutrition. This is indicated by low weight-for-age and by other subnormal body measurements, such as height, arm

circumference, and head-to-chest ratio. An examination may also reveal wasted muscles, hair-color changes resembling those seen in kwashiorkor, and apathy (see Figure 4). Such children may be precipitated into a more severe malnutrition, such as kwashiorkor, by an attack of measles, a diarrheal disease, or pneumonia. Prevention is better than cure; but treatment of undernutrition, as shown, for example, in Figure 5, should result in recovery, as shown in Figure 6.

Screening for Malnutrition

Prevention of disease is, of course, one of the most important tasks in world health. The prevailing deficiency diseases and infections, so common in infants and children in developing countries, undoubtedly are preventable to a great extent, largely by existing means. An important task of the staff, particularly at MCH (Mother and Child Health) centers and at "under-5 clinics," is to trace those children who are in danger of becoming malnourished, so that the development of serious deficiency disease can be prevented. Such clinics, however, usually serve a large number of patients, and it may be difficult to screen out for special care those children who run the greatest risks of developing serious illnesses.

Weight charts. When a child is under five years of age, weight is the best method of assessing the state of nutrition. It requires considerable skill and experience, however, to decide from a single examination or weight measurement--or even a series of weight measurements--if a child is growing satisfactorily.

The best and simplest way is to plot the weight on a specially designed weight chart, shown in Figure 7. At each visit to the MCH center or the under-5 clinic, the weight is plotted on a chart. With some training, auxiliary staff can do this easily. Charts such as these have been tested by WHO in many countries and have been proved to be of great value. They can also be worked out locally. Because weight is related to age, difficulties may arise in those areas where mothers are uncertain of their children's age, but information can be obtained with reasonable accuracy, at least for infants and small children, by relating the date of birth to local events. The construction of a calendar of local events that will be known by the majority of the community is useful for other purposes, as well.

Flattening of the child's weight curve is the earliest sign of PEM, and may precede clinical signs by weeks or even months. In some places, the mother keeps the chart and the clinic tells her the significance of the lines on the chart. The upper line usually represents the median of the local or international standard weights,

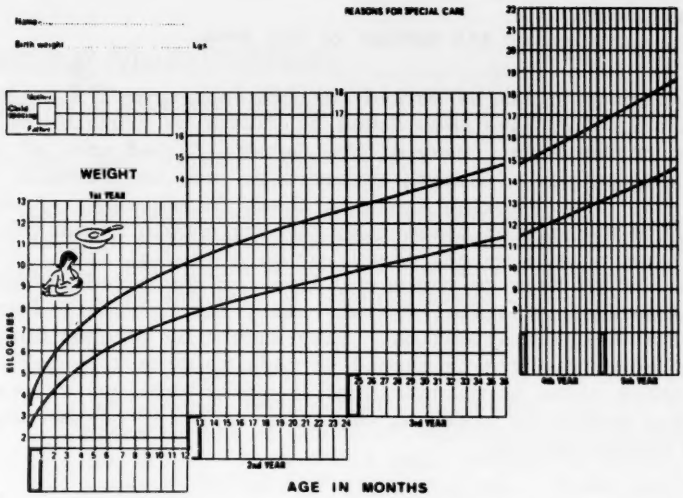

Figure 7. A model weight chart for use in MCH and Under-5 clinics in developing countries. (WHO, Geneva.)

and the lower line indicates 80 percent of that standard. In other places, the weight chart is kept at the clinic; in still others the mother keeps a duplicate copy of the clinic's chart. The arrangement that is best depends on local conditions and the degree of cooperation by the mothers.

High-risk factors. Various studies have identified certain high-risk factors that have shown some relationship with the child's nutritional state. These include:

Low birth weight.
Twins or multiple births.
High birth order.
Death of siblings, particularly if before 12 months of age.
Measles, whooping cough, and severe or repeated diarrheal episodes in the early months of life.
Death of either parent, a broken marriage, or an unmarried mother.

Illiteracy of mothers, in areas where there is a fair degree of literacy, and low intelligence.
General poverty.
Recent migration of the mother to the area.

A high-risk list can be worked out for each area. It should be based on factors that have been found to relate to protein-energy malnutrition in the area. Many of the factors listed are, of course, not within the control of health authorities, nor undesirable, but they may be useful as showing areas to check for disease. A child with designated numbers of these risk factors should be marked by a red star, probably on a weight chart, or on a special list. A "red-star book" might be kept on these children, or their red-starred charts could be kept separate. In any case, the red-starred children should be given special attention. They should be weighed more frequently, and more home visits should be made to detect faltering growth and other signs of malnutrition in their earliest stages. If possible, they should be examined weekly by a doctor or the most experienced health worker.

[Extracted from Manual on Feeding Infants and Young Children, Chapter 4. Published by the Protein-Calorie Advisory Group of the United Nations System, New York, 1976.]

Note: This manual is available in English, Spanish and French editions, and can be obtained from local offices of WHO, FAO or UNICEF, or from FAO Headquarters, Via delle Terme di Caracalla, Roma, Italy. A 1981 edition of the manual is currently being prepared.

Overcoming Malnutrition: The Role of Fats and Oils

Claire Dearden, Pat Harman, David Morley

[Over the last ten years many studies have emphasized that energy deficiency is more important than protein deficiency in the etiology of malnutrition. This paper discusses the advantages of increasing the quantity of oils and fats in weaning diets in developing countries.]

Currently there is a great debate over what nutritional requirements would best improve the diets of the millions of undernourished children in the world. Many diets rely heavily on wheat, rice, cassava, maize and other staples. These staples, when cooked, are bulky and have a low energy density. Small children have difficulty eating sufficient quantities of these foods to meet their daily requirements for energy. The addition of a small amount of a high energy food such as an edible oil to a cooked staple increases the energy density, and has an important softening effect on the food. This means that less water needs to be added during cooking to provide a food of a soft consistency that can easily be eaten by a young child. Supplements of oil or fat in the diet are thus highly desirable.

In many developing countries fats and oils, especially in their processed form, are expensive. Where oil-rich foods such as groundnuts and red palm oil are locally available, they can make an important contribution to the child's weaning diet.

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The Weaning Period

By our definition, the weaning period starts with the addition of foods other than milk and ends when breast feeding ceases and the child is wholly on a general diet. In developing countries weaning usually spans a period from age four months to about three years. This is the time when a child's growth is most likely to become inadequate if given too little nutrition. The child's intellectual potential may also be reduced in this period due to inadequate nutrition; the proportion of the child population so affected is uncertain but may well be considerable.

Common weaning diets in developing countries consist of a gruel (pap or porridge) made from cereals or starchy tubers. The significant difference between the composition of breast milk and these weaning foods is in the fat content. In breast milk, fat contributes 52 percent of its total energy, whereas with most cereal staples only 2-10 percent of total energy is fat-derived. Fat is a concentrated source of energy having more than twice the energy content of carbohydrate and protein.

Advantages of Fats and Oils

The purpose here is to emphasize that the addition of fats and oils not only has the advantage of increasing the energy content of a weaning gruel, but also has an important effect on the viscosity of the gruel. A gruel of given consistency, if it includes oil, can be made with more of the staple and less water, and thus it achieves a higher energy density.

Bulk. Traditional weaning diets are frequently bulky, and young children under the age of three have difficulty in eating sufficient amounts to meet their energy and protein requirements. Small children, because they are growing, require twice as much energy per kilogram of body weight as an adult. Their small stomachs can take only limited quantities at a time, and even increasing the frequency of meals may not raise the total food intake sufficiently. This problem is clearly demonstrated by Rutishauser and Frood's study of young Ugandan children recovering from malnutrition. The figures in Table 1 show the comparatively low energy intakes of children eating the traditional weaning diets, despite the fact that in this study they were fed as much as they wanted five times daily. A similar study by Jones and Pereira showed an inadequate energy intake by pre-school Indian children offered as much as they could take of a high cereal diet. At home children of this age are fed only once, twice, or at the most three times daily. Low intakes of energy and protein are therefore to be expected. Children eating the milk-based diet with its high fat content ate less solid food and yet achieved higher protein and energy intakes.

Table 1

THE PROBLEM OF BULK IN TRADITIONAL HOME WEANING DIETS

	Traditional Weaning Diets	Milk-Based Diets
% Energy from fat	2-18%	66%
Intakes of Children Aged 1-3 Years		
Mean daily intake of solid food (g)	717 (± 83)	330 (± 45)
Mean daily intake of energy (kcal per kg body weight)	98 (± 10)	138 (± 6)
Mean daily intake of protein (g per kg body weight)	1.9 (± 0.2)	2.5 (± 0.1)

Source: Rutishauser I.H.E. and Frood, J.D.L. (1973), British Journal of Nutrition, Vol. 29, p. 261.

When it is impossible to raise the quantity of food consumed (Figure 1) because of its inherent bulkiness, increasing the energy density is the only way that the energy intake can be improved. Fats and oils provide 9 kcal (kilocalories) per gram compared to 4 kcal per gram from carbohydrate or protein, and when included in the diet have the greatest impact on dietary energy intake. Perhaps the improved nutrition, growth, and general health of children in Europe and North America owes much to the increase in the consumption of fats and oils over the last 150 years.

Viscosity. Weaning involves a transition from a fluid to a solid diet. At first the weaning child is able to tolerate only soft semi-solid food. Unfortunately, in order to achieve a gruel of soft consistency, the mother over-dilutes the food. The viscosity is thereby reduced but the child receives too little energy. Viscosity is affected by four main factors:

Dilution. Adding water reduces the viscosity but also lowers the energy content of the weaning food. In order to meet energy requirements, a one-year-old child may need to consume four liters daily of cereal gruel which has been diluted to a drinkable consistency (95 percent water). This dilution will result in an energy density as low as 0.25 kcal/g.

Solubility. In general, cereals absorb more water than tubers to produce a gruel of the same consistency. An example of this in

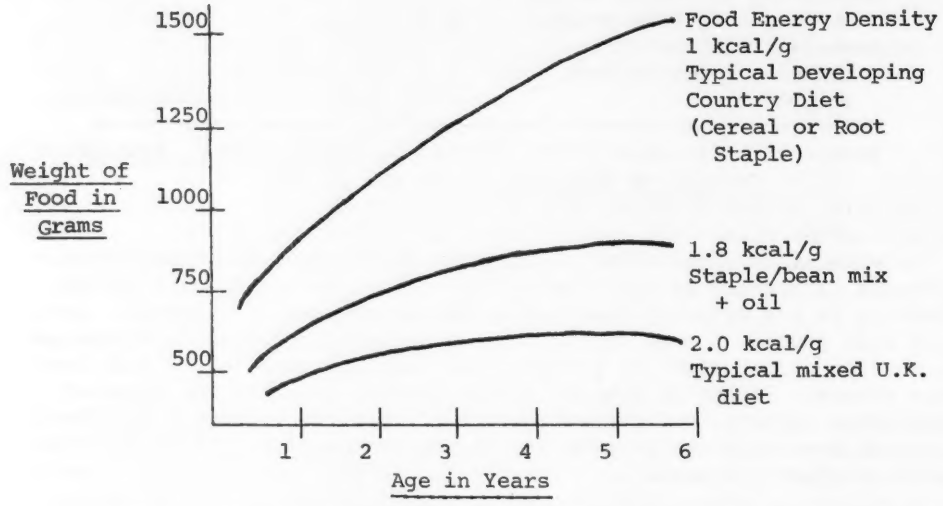
European cooking is the use of cornstarch as a thickening agent in custard.

Temperature. Temperature and viscosity are inversely related. Most food is eaten at around 35°C, at which temperature a maize gruel with even 90 percent water content like a custard is still a semi-solid.

Fat Content. Addition of fat or oil to a staple diet has a dramatic softening effect, producing a liquid gruel at a lower temperature and/or lower dilution level.

Figure 1

FOOD INTAKES IN RELATION TO ENERGY DENSITY



Source: Adapted from C.W. Binns, unpublished study on palm oil, 1975; and Rutishauser and Frood, op. cit.

Figure 1. These curves illustrate the difference in food bulk required to achieve the same energy intake in three different diets for children ranging from one to six years old. To illustrate: in order to achieve the same energy intake, a 2-year-old child in a developing country (top curve) needs to eat twice the weight of food of a largely staple diet as a 2-year-old eating a U.K. diet (bottom curve). However, by adding oil to a developing country diet mix (middle curve), the energy density can be improved, making it similar to that of a typical mixed U.K. diet.

Dietary Constraints

The suitability of adding fats and oils can be considered under four subheadings.

1. Nutritional requirements. In planning a weaning diet for developing countries, the main objectives are to ensure adequate growth with sufficient surplus energy to allow the child full activity. The following nutritional requirements need to be met:

Estimates of daily protein and energy requirements. At one year of age, 5.4 percent of a child's total energy should be contributed by protein. A child's requirements are 1.35 g of protein (as protein which is 100 percent utilized) and energy requirements are 100 kcal per kg of body weight.

Protein/Energy ratio. Although energy is important and oil provides concentrated calories, the need for protein also remains important. Fats should not be fed in such high proportions that the protein/energy ratio of the food mixture becomes too low.

Excess fat in the diet. Because of its high satiety value, addition of too much fat as an energy-rich supplement may mean the child's appetite is satisfied before all the food is eaten. Protein and other essential nutrients such as minerals and vitamins may be wasted in the unfinished portion of a meal.

Dietary fats and essential fatty acids. Unlike adults, the child under two cannot easily manufacture fats from carbohydrates, which makes fat an important dietary component. Fats also contain essential fatty acids which are necessary for growth of cell structures. Of the energy supplied to the child, three percent should be in the form of essential fatty acids.

2. Physiological suitability. *Utilization of fat.* Young children eating low-energy-density diets of some developing countries may have an energy deficit ranging from 20 to 30 percent of recommended allowances, depending upon age. If half this deficit were met by an increase in added fat and half by an increase in quantity of the diet now being consumed, the total energy derived from fat would be about 25 percent, which is stillwithin the acceptable limit for children. As an example, in Central America maize-bean based diets fed freely to children ages 15-30 months fulfilled the protein and energy requirements when the diets contained 27 percent of their total energy as fat.

TABLE 2
INCREASING THE ENERGY CONTENT OF A SOUTH AMERICAN MEAL FOR A 2-YEAR OLD WITH 2 TEASPOONS (10g) OF OIL

Food	Weight	Energy
Maize (60% extracted)	50g	177 kcal
Kidney Beans	20g	68 kcal
Total Energy of Meal		245 kcal
Add Red Palm Oil	10g	90 kcal
Total Energy of Meal		335 kcal

In this modified meal protein contributes 10.5% of total energy. By adding oil the energy is increased by 37%. Oil supplies 27% of total energy. The energy density of the modified meal is 1.8 kcals per gram (see Figure 1). Such a meal should be consumed three times a day to provide an adequate intake.

Palatability. The taste as well as the consistency of a food will affect most children's appetites and thus the amount they eat. In the weaning period the child adjusts from the bland taste of breast milk with a cereal gruel to the varied flavors of the adult diet. This adult diet may be highly spiced, making it unpalatable, and contain solids which are difficult for the child with few teeth to chew. For these reasons new foods need to be introduced gradually to allow the child to become accustomed to them.

In a nutritional study done by M.A. Church in 1977, he plotted values for foods well accepted by children and found that they fall within quite well defined limits. Dry foods are only palatable if sufficient fat is added or is already present in the food, as in groundnuts; for this reason, oils are used in many traditional diets to improve their palatability. In a study of Highland children in Papua New Guinea, palm oil was added to the weaning diet. Despite their not being used to the strong flavor of this oil, only six percent of the children objected to the taste. Few foods are eaten if they contain more than 60 percent solids as fat. This corresponds well with the physiological limits outlined in Figure 2. In this figure Church has suggested an area he calls the "Palatability Tolerance Zone" based on water, fat, and energy content of foods.

Food Preparation. Grinding and mashing of foods such as fish or groundnuts can make protein/energy-rich adult foods available to the small child. In West Africa ground legume flour may be made into a stiff paste with water and fried in oil, or oil may be added to the flour which is then wrapped in leaves and boiled or steamed.

Other traditional methods of food preparation may successfully improve the energy intake of small children. In a classical study in South India a traditional method used in a rural community was taken to a laboratory and, after thorough investigation and modification, successfully re-introduced to the village. The method involved washing and soaking sorghum grain overnight, malting (germinating) for four days in jute bags, sun-drying, toasting to improve the flavor, and then grinding. The flour from this germinated grain produced a low viscosity gruel with an energy concentration three times that of a gruel made from normal sorghum flour. The period of sun-drying was found to be important as it allowed the amylases (enzymes specific for starches) produced by germination to break down the starch molecules. A similar process was found not to alter the energy concentration of grams (legumes) but did improve their palatability.

Some food preparation practices can be harmful and result in a reduction of the quality of weaning foods. An example of this is *eko*, a starchy pap made from maize in West Africa. Although local uncooked maize has a high fat content of 51 g/kg, preparation of *eko* involves soaking the grain in water for 48 hours and removal of most of the germ and husk. This results in an agreeable white smooth product in which there has been a loss of 81 percent of the fat and 41 percent of the protein. The proportion of energy available from fat is reduced from

11 percent in raw maize to 2 percent in *eko* pap and the child (aged 1-3 years) would need to consume 4-5 liters per day of this food to meet his energy requirements.

Figure 2

DIET ZONES

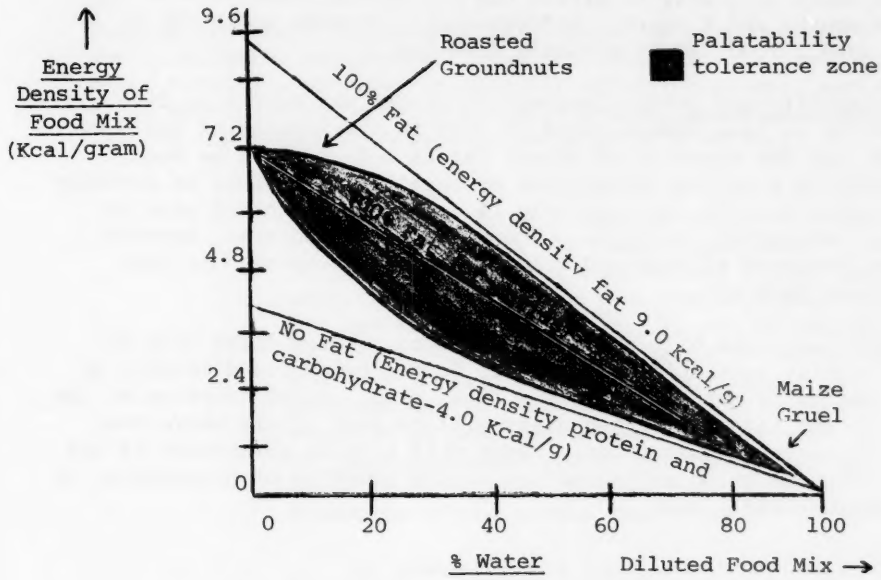


Figure 2. All diets lie within the possible food mix zone (shown by the triangle) and most diets lie within the palatability tolerance zone (shown by the darkened ellipse). They range from roasted groundnuts with high energy density to a maize gruel which may consist of more than 90 percent water and thus have an extremely low energy density.

Source: Church, M.A., The Importance of Food Consistency in Supplementary Feeding and the Weaning Process, 1977, p. 279.

3. Cultural acceptability. *Customs and beliefs.* Changes in the food given in the weaning period will be affected by the villagers' attitudes. Some foods may not be given; for instance, in Malaysia fish is believed to give toddlers worms. In many cultures there are "prestige" foods such as *motoke* in Uganda which, although considered to be a cultural "superfood," unfortunately has a low energy density of only 1 kcal/g. Other areas are more fortunate. In a region of Northern

Uganda a groundnut and sesame-seed paste is used in the traditional weaning diet. This has the advantage that an anti-oxidant in the sesame seed prevents the oil in the food from turning rancid; in areas where this is used the incidence of protein energy malnutrition is lower than in comparable areas.

Food priorities. In many societies men eat first and women and children eat what remains. In these areas small children are likely to miss out on the valuable and limited protein-energy supply. This is particularly so where the young child's appetite is reduced by an infection which is likely to affect him one day in three between the ages of 6 months and 2 years. Unfortunately, in some societies if a child is unwell food may be withheld from him.

4. Availability and cost. Consumption of fat *per capita* in developing countries is less than a third of that in the industrial parts of the world, and the quantity of animal fat is only a sixth as much. Fats contribute a smaller proportion of total energy intake in developing countries; in 1974 this was only 14 percent as compared with 33 percent in industrial countries. The developing countries, however, are large producers of fats and oils; but much is exported in cash crops such as palm oil.

Mothers will use oils and fats to add to weaning diets only if they are locally available at low cost, or can be produced locally by a simple method of extraction from a local crop. Rapid adoption of the use of oils and fats in weaning diets will be most likely where they are already used in adult foods. There will also be advantages if the oil does not have to be extracted, as in the pounding of groundnuts, to make an appropriate paste.

Conclusion

While the volume of food intake depends on the frequency of meals and on the consistency and palatability of food, the nutritive value of that food intake ultimately depends on the energy density and the nutrient content. The main advantages of oils and fats as weaning diet supplements are their favorable effects on food energy density. This is achieved only partly by their high energy content; equally or more important is their ability to decrease viscosity and increase palatability of cereal staples. Most existing weaning diets in developing countries would be much improved by the addition of oil or fat; but the promotion and use of fats and oils in the diets of young children in these countries will depend on their local production, availability, and cost, and particularly the rural people's attitudes toward such foods.

[Extracted from Tropical Doctor, July 1980, Vol. 10 pp. 137-142, Copyright© Royal Society of Medicine, London, England.]

Leaves: An Underrated Source of Nutrients

H.A.P.C. Oomen and G.J.H. Grubben

[Leaves from many common tropical plants can provide essential minerals, vitamins and protein. The following article lists some of the basic nutrients provided in commonly occurring leaves, explains why these nutrients are crucial to child health, and emphasizes the particular importance of leaves in the diet of a child.]

The relationship between health and the uses of herbs is as old as the human race itself. For centuries man has sought comfort and relief from his ailments through products from the vegetable kingdom. Our emphasis here, however, is not on the medicinal or curative properties of plants but rather on their preventative and nutritive properties. What health problems can be associated with the inadequate consumption of leaf vegetables? Who is most vulnerable to these problems? Which nutrients are contributed by green leaves? What is their significance within the framework of the common food intake?

In assessing the function of protective nutritional supplements we soon discover that those who need them most, that is those who are most vulnerable with regard to health, are the rapidly growing small children, and the women whose metabolism is burdened by pregnancy or lactation. In many places in the tropics, the next most vulnerable category is that of the school-age children. How might the addition of even modest quantities (100g or even less daily) of leaf vegetables to the common diet prevailing in the

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less-privileged parts of the tropics affect these groups? This question might best be answered by examining the individual nutrients present in leaves, in order of importance.

Carotene

Carotene is the yellow pigment hidden by the green chlorophyll in every leaf. It is the rudimentary component of vitamin A. When milk, eggs or liver are missing from the diet, leafy vegetables are a critical source of this raw material for producing vitamin A in the body. Vitamin A has many essential functions in maintaining cellular structures in the body; it protects epithelial surfaces (epithelial surfaces are composed of membranous tissue covering most internal body areas, organs and the outer surface of a mammalian body). Vitamin A also promotes growth. At birth the newborn receives a small amount in the liver which then is maintained by breast-feeding. The development of satisfactory liver stores in a child is a vulnerable affair; after weaning, the 2-4 year-olds often develop signs and symptoms of vitamin A deficiency (avitaminosis A). This is manifested by degeneration of the eye surfaces of which destruction of the cornea is the most serious. Such a child, if it survives, will be blind or suffer from serious vision impairment for the rest of its life. This is xerophthalmia (literally: dryness disease of the eye), the worst manifestation of avitaminosis A. Survival in malnourished children, general health, growth and the overall function of body processes, can also be affected.

Since sufficient preformed vitamin A obtained from milk, eggs or liver is rare in diets all over the tropical world, most toddlers in South and East Asia, in Africa, in Haiti and Brazil have to rely on carotene for vitamin A manufacture. The number of children newly blinded from this avitaminosis A has been estimated at about 120,000 a year, and many may have died of associated disorders. Unfortunately, their eyes and possibly even their lives would have been spared if carotene had been present in their daily fare. The tragic irony of avitaminosis A in countries like Indonesia where vegetation abounds was summed up in four words by Dr. Burgess of WHO in 1953 when, discussing the xerophthalmia problem in small children, he wondered at its impact in "so green a country."

Why emphasize leaves? Among roots, carrots, and among fruits, mangoes are outstanding sources of carotene though tomatoes, pumpkins and papayas contain considerable quantities. Unfortunately, the distribution and availability of these fruits and vegetables is much more erratic and seasonal than leaves. In addition, the quantities required, of tomatoes for example, are much higher (see Table 1) and usually so is the price.

TABLE 1

NUTRIENTS IN POPULAR TROPICAL LEAVES, LEGUMES AND FRUITS
(in 100g of dry matter, edible portion: averages of four kinds each)

	protein g	calcium mg	iron mg	carotene mg	vitamin C mg
Leaves	29.8	1114	18.0	38.2	552
Legumes	30.0	153	8.0	0.2	7
Fruits	4.6	117	3.1	4.6	229

Leaves: amaranth, cassava, kangkong, taro
Legumes: peanuts, soybeans, mungbeans, cowpeas
Fruits: banana, papaya, orange, mango

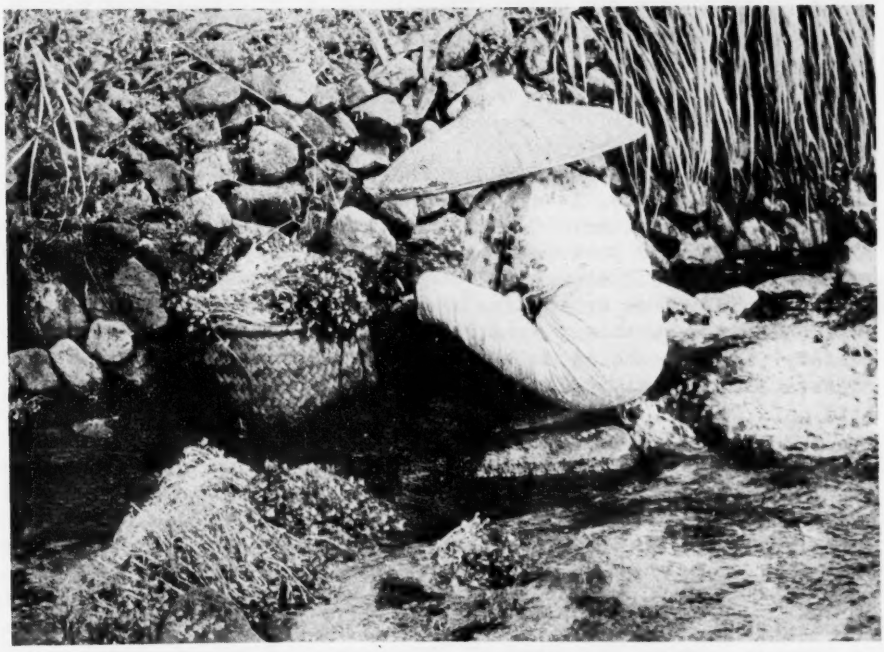

Figure 1. Cultivation of watercress *(Nasturtium officinale)* in the mountainous regions of West Java. The soil is too stony for rice culture and plenty of water is available.

Protein

In the past twenty years the insufficiency of protein intake has been a general concern in the health policies of governments and international agencies. Much of it is centered around the effects of malnutrition in the small child, and the concept of the "protein gap" has been used. But this view of protein shortage as the central cause of nutritional misfortune has been criticized recently. Many believe that the problem is not so much the paucity of protein itself in the diets as the limitations in total caloric intake. Nevertheless, protein is a basic nutrient and an important element in nutritional rehabilitation of the sick or marginally fed child.

The dry matter of leaves contains as much protein as beans, which have a special reputation. Leaf bulk is greater than beans because leaves contain about 70 percent more moisture than dry legumes. A portion of 200g of leaf vegetables may supplement the diet with 6-14g of protein. The nutritional quality of plant protein is different, and for humans usually lower, than that of animal protein. But this can be compensated for by consuming a greater variety of plant products which can provide all the components needed to work together in body-building.

Ascorbic Acid

Scurvy, characterized by bleeding gums, bleeding under the skin and extreme weakness, is a condition brought on by a deficiency of ascorbic acid or vitamin C. All fresh fruits and vegetables contain vitamin C. A good source for infants would be papaya, as the mature fruits are soft and fleshy and they are widely available. Bananas, tomatoes and citrus fruits are also good sources. In the absence of fruits, leaf vegetables, even given in small quantities, could easily satisfy requirements of children and adults alike. For example, four cassava leaves a day would suffice to ward off a state of ascorbic acid deficiency.

Iron

Iron-deficient anemia is a very widespread problem all over the world and small children are quite vulnerable. Iron is found in small quantities in a variety of foods, but the dietary iron actually available for human absorption is generally better when coming from animal sources. If these are absent, the best alternative is leaf vegetables. An average portion of leaves of 100g provide 4-7mg of iron a day, which is sufficient for a small child and a considerable contribution to the recommended daily intake of an adult.

Figure 2. With her baby conveniently on her back, a housewife gathers green leaves of bitter leaf *(Vernonia amygadalina)* from her garden to prepare a meal. Benin.

Folic Acid

Like iron, folic acid is a nutrient responsible for the structure and the function of red blood cells. Folates (folic acid salts) are present in many foods, but only certain animal products and leaves are rich sources. An average portion of 100g of leaves per day would wholly cover a child's minimum daily requirement of folic acid. The same sized portion would cover half of the average adult's daily minimum requirement of 200mcg (micrograms). Pregnant and lactating women have higher than average adult requirements and they are more vulnerable to the type of anemia caused by lack of folic acid.

In industrialized countries, the fortification of common foods is often used to counteract deficiencies of folates, iron and ascorbic acid. The missing nutrient is added to sugar, bread or salt before

distribution. However, this approach is often difficult in the Third World, especially in rural areas based on a subsistence economy. These nutrients therefore have to come from the local diet, and a liberal consumption of leaf vegetables is the best insurance against deficiency of these nutrients.

Calcium

Calcium, like other mineral compounds in our food, comes from the soil and is stored in plants. Milk, the sole food of a rapidly growing, skeleton-forming young animal, is a very rich source of calcium. Unfortunately for young growing children in many parts of the tropics, milk is not available in adequate quantities after the breastfeeding ends, and beans and starchy staples contribute only limited quantities of calcium. In these conditions, green leaves can be a common source of calcium to counteract deficiencies. Aside from growing children, a nursing mother loses as much as 300 mg of calcium daily in her milk. The high calcium content of leaves makes it possible to counteract this loss if she consumes between 100-200 g/day.

Figure 3. Pick your leaf vegetables from a shrub or tree. They are always there. Just strip the tender leaves of these Sauropus twigs and you have no need to go to the market. (Indonesia)

Quantities of Nutrients Supplied By Leaf Vegetables

What is the practical effect of an average portion of 100g of leaf vegetables on the diet of a typical child in a poor tropical environment? Assume he is six years old, weighs 20 kilograms (44 lbs.), and consumes 1,400-1,500 calories daily. The bulk of his food is provided by the staple, most often rice, maize, wheat or cassava. Assume further that he eats 30g of beans a day, but that milk, eggs, fish or meat do not contribute significantly to his fare. His parents may choose from half a dozen local leaf vegetables. Composition of these leaf vegetables can differ considerably, but something like the following occurs if he consumes 100g daily. (When cooked, 100g does not exceed two heaped tablespoonfuls, so there is little bulk relative to the local staple.)

The protein of the leaves will add 15 percent or more to his total protein intake. The leaves will add over 100 percent to the calcium and iron present in his food. His vitamin A and vitamin C requirements will be 300 percent fulfilled. The B vitamins (thiamine, riboflavin and niacin) would receive a boost of 15-30 percent. The folic acid in the leaves fills his daily requirement. It would be very difficult to quote any other common foodstuff which provides this spectrum of protective effects (see Table 2).

TABLE 2

PERCENT OF DAILY REQUIREMENTS (WHO/FAO) OF NUTRIENTS PROVIDED BY 100g OF A DARK-GREEN LEAF VEGETABLE, e.g., AMARANTH

Nutrients	Quantity Supplied	Percentage of Requirements	
		Pregnant Lactating	Toddlers 1-3 Years
Macronutrients			
protein	4.5 g	11%	28%
Minerals			
calcium	350.0 mg	32%	77%
iron	4.3 mg	48%	57%
Vitamins			
carotene	6.0 mg	200%	400%
thiamine	0.3 mg	25%	50%
riboflavin	0.3 mg	18%	37%
niacin	1.3 mg	8%	14%
ascorbic acid	70.0 mg	230%	350%
folic acid	85.0 mcg	24%	84%

This example assumes that the staple food is a cereal. If the staple were fermented or dry cassava, the beneficial effects of the leafy vegetables would be even greater. In case of doubt of the adequacy of particular leaves, just add a little more, and vary the species eaten.

Leaf Vegetables in Infant Foods

It is difficult to give guidelines for the composition and quantities of food for an infant under one. One must first examine the local staple food and review the relevant possibilities. Although leaf vegetables are nutritionally superior, ripe tomatoes or papayas are suitable alternatives.

A source of fat should also be present in the diet. Coconut milk would be a natural source in South and East Asia; in Africa, peanut sauce can often be used. In West Africa, red palm oil is a fine source of fat and is doubly nutritious because it is so rich in carotene. Fish, eggs, milk or skimmed milk should be used whenever available and affordable. Breastfeeding should continue for as long as possible, but there will always be circumstances under which this ideal food source is not available or insufficient.

Nutritional adequacy, ready availability, and low costs are the prime considerations in basic fulfillment of requirements in a nutritionally marginal situation. If the infant is still on the breast between 6-12 months but with breast milk output declining and nutrient requirements increasing, then quantities sufficient for initial supplementation, for two meals daily, might consist of:

--100 g whole maize flour, millet flour or rice.
-- 30 g (dry) of legumes like beans, cowpeas, green gram, etc.
-- 30 g of dark green thin-leaf vegetables.

The mixture furnishes about 500 calories, 18g of protein and 2mg of carotene. Vegetables should be mashed or sieved, a little oil or fat added and made into a rather thick porridge to contain sufficient nutrients in a small volume. Mothers would be well advised to start gradually feeding mashed vegetables to infants at an early age, e.g., in the fourth month, so the baby can be initiated to the taste.

A child between 12-24 months should receive two or three times the amount of leaf vegetables for the 6-12 month old. Since it has teeth, a soft consistency is less relevant. The maize-peanut and maize-bean mixtures have proved successful in Africa, and the rice-green gram mixture has benefitted Indonesian children for many years now. If gari, cassava or sago are the staple foods, the addition of (dried) fish would be essential.

Figure 4. Selling African cabbage leaves (*Brassica carinata*) on a village market in the highlands of Kenya. Even those small quantities contribute a little cash.

Potential Drawbacks of Leaf Consumption

There are a few factors which require caution in the consumption of leaves. One is the potentially toxic factor of hydrocyanic acid. This acid is not rare, though it comes in variable quantities in otherwise edible leaves. It is, however, as highly volatile as it is

poisonous, and evaporates at a low temperature. Therefore, any preparation which includes heating will render the leaves innocuous. A well-known example is cassava, both the tubers and the leaves. The high HCN content does not keep devotees of cassava leaves from consuming them, but they are well aware of how to prepare them.

A different and less important drawback is oxalic acid and the oxalates (oxalic acid salts) present in many leaves. Amaranth is one example, and many sourish leaves like purslane, Celosia, Basella and Talinum contain appreciable quantities. Oxalic acid is mildly toxic; its salts remove some of the calcium entering the body from food. In leaves of some taro species fine oxalate crystals, called raphides, are present. They cause itching under the cook's nails and a burning sensation on the tongue of consumers. Prolonged or repeated cooking after changing the wash-water, adding potash, consuming non-irritating species, or using young leaves only can alleviate this problem.

Exactly how many of the nutrients in the leaf pulp are absorbed with beneficial effects into the human body is not sufficiently known. To maximize absorption one should choose leaves that are neither too old and coarse nor too young and immature and add a little fat. Young children should be assisted by mashing or sieving the leaves before eating. Prolonged boiling may cause loss of certain nutrients, but some cooking to produce a soft or at least wilted texture is preferable to eating uncooked vegetables or fresh salads.

In conclusion, although there are a few drawbacks to the consumption of leaves, sufficient care in the preparation of leaves alleviates most of these problems. Their general availability and high nutritive value provide adequate reason to encourage increased consumption of leaves. Leaves alone will not provide the solution to the staggering problem of global malnutrition, but they can make a significant contribution.

[Adapted from Tropical Leaf Vegetables in Human Nutrition, Chapters 4 and 5, pp. 24-41 and 51-55, Communication 69, Department of Agricultural Research,]

Editorial Note: This article is addressed to nutritionists and does not deal in depth with peoples' tastes, and whether they want to consume leaves or leafy vegetables. Finding ways to prepare leafy foods that will overcome unfamiliarity and unpalatable taste is a challenge to ingenuity, and methods would vary by location.

Some Elements of a Child Nutrition Program

Margaret Cameron and Yngve Hofvander

[Some of the important elements in a program of child nutrition, if it is to be successful, include a body of accurate information on the food habits and related circumstances of the people affected, and a continuing effort to inculcate nutritional education. The advantages of nutrition rehabilitation units are described.]

Information Needs

Before a successful program can be started in a new area, a great deal of information must first be collected. Some of the information needs are the following.

Find out about the people. The first step is for program designers to get to know and understand how the people in the area to be served actually live and, at the same time, to gain their confidence and respect. The community worker should be consulted, and if he/she is new to an area should strive to become familiar with local traditional leaders and their pattern of authority, the social customs and cultural beliefs, the work people do, and their level of education. The worker also should try to discover what the people think are their most urgent priorities or needs. All this information must be conveyed to the national planning authorities.

Where there are no resident community workers, outside researchers will have to collect the information. Because of difficulties with dialects, an interpreter

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may be needed; but all personnel should learn a few words of greeting before any interviews begin. The interpreter must be a person who is acceptable to the community and its culture.

Information on the most relevant health problems is essential. This will give a clear idea of specific nutritional deficiencies and the most common infections or parasite infestations in the community. Any attempts to make changes must be built around the best of the traditional customs.

Find out about food. Every community has its traditional feeding patterns and beliefs about certain foods, some of which are favored and prestigious while others are taboo. Usually some reasoning lies behind these beliefs, and that should be ascertained. In addition to knowing what foods are used, information must be collected on the available kitchen utensils, storage methods, water sources, fuel and any difficulties in obtaining it, cooking methods, and meal distribution within the family.

Apart from observing what goes on in the households while endeavoring to know the people, a great deal can be learned from looking at the village gardens, the fruit trees, bushes or vines, and by frequent visits to the local market to see what items are stocked and what is bought, their unit costs, and the usual amounts purchased. Discussions with the people will help a worker to discover some of these facts and, at the same time, will establish a sympathetic contact between the worker and the new community.

Foods with high prestige are not always the most nutritious, but they may be made more valuable nutritionally and still keep their status by small modifications or additions. Finding the means by which this can best be achieved will depend on careful observation.

Find out about family economy. Proposals for improving the infant's intake of food can be made only after establishing where the food comes from. Advice depends on whether the household is dependent on a subsistence economy in which the food is grown at home, or whether it is all bought at a market. The quantities of food available and how much money is spent on it also must be known. In either case, expenditure is affected by market prices, which to a great extent influence the quantity of available food for any family. Giving advice on the budgeting of home-grown food supplies from one harvest to the next is more essential in the rural areas than how to budget money, which is more important for those who live in towns. Only by informal discussions and indirect, tactful questioning will it be possible to get some indication of how the family budgets are used. It is particularly important to find out if money is spent on special infant foods, what these are, and why they have been chosen. No

nutrition education can begin unless this kind of information is known and taken into account.

Find out about environmental hygiene. Personnel must make a point of understanding the hygienic conditions in the households. If the general hygiene in the home is poor, a high rate of intestinal and other infections is to be expected. Conditions can be worse if methods of storing and handling food are also unsatisfactory. Clean food and clean utensils are essential for successful feeding, and of supreme importance if the infant is not being fed from the breast. The bottles, cups, spoons, or other utensils used for artificial or supplementary feeding, how they are cleaned and where they are stored, and actual methods of preparing the food should all be investigated. Personal hygiene also should be stressed in nutrition education.

Making the plan. A plan for a nutrition program should be based on all the information which has been collected. The program most likely to be successful is the simplest, and involves the least possible change in traditional ways. It needs to include the following:

what mixtures of food are best to recommend, and when they can and should be given;
where the mothers can be taught how to prepare them;
who will teach them;
how teaching can be followed up in the home;
where and how checks can be made on children's growth and development;
what records should be kept, and how this has been organized;
who will be responsible for assessing the success of the program.

The Education Component

The kinds of people working in nutrition education differ in each country. Some places have trained nutritionist-dietitians, with assistants, but in many countries they are few in number at present. Nurses, health visitors, home economists, community nurses, midwives, and auxiliaries are trained by the health or agriculture ministries. Local women or girls in their late teens have been taught to do simple teaching in their villages. Basic training is needed at all levels, and wherever possible this should be extended to short, but regular, refresher courses. Such courses encourage the staff and auxiliaries, bring them up-to-date, and coordinate teaching. The more they understand all aspects of the work, the more persuasive they can be in their dealings with mothers and children. With exchange and ideas through discussions, the staff becomes more flexible and better able to suggest alternative ideas to the women they go back to teach.

In an agricultural community, education should not be limited to mothers or grandmothers. Fathers, often farmers, should be encouraged to join in any teaching program. They may have more interest in their crops if they realize how important they are for their children and are shown how the yield may be increased for consumption, for preservation, or for marketing.

In urban areas, housing and cooking facilities may be extremely poor. The mothers may go out to work and the available market foods may be unfamiliar, and expensive. These problems form the basis for teaching the mothers at a time when they are free to join in some community group.

The success of teaching depends on the personality of the teacher, as well as on her training. She must be firm but sympathetic and have a sense of humor. She must be prepared, and take the time, for a chat with each mother so she can become familiar with individual problems.

The timing of any class should be convenient for the mothers and may coincide with clinic visits or some other community gathering. The setting for the class should be comfortable and relaxed, to encourage questions and discussion. Often a class can be held outdoors, sheltered from the strong sun and where everyone can hear and see what is being demonstrated. The group should be kept small. A series of short demonstrations for 10 to 12 mothers is much more satisfactory than a longer one for more people (Figures 1 and 2). There should only be a few points made in each lesson, and they should be simple and clear. They will be remembered more easily if they are related to something already familiar to the mothers.

The lesson should be short, because mothers with small children will have difficulty concentrating for long and may be some distance from home. Their interest should be attracted right from the beginning, perhaps by asking questions about their homes, their families, or their last visit. Whenever possible, one of the mothers should be asked to assist in the teaching. This may be particularly convincing to others if she herself has had a malnourished child who has improved on "village foods" only. Often such mothers are eager to teach others about what has helped her and her child.

Any demonstration should be in terms of foods and utensils with which the mothers are familiar, and which are within their means. Foods should be those they can produce on their farms or in their gardens. Better budgeting of food supplies should be taught to insure enough food from one harvest to the next. It should be pointed out that the temptation to sell the main crop of beans at favorable prices after harvest is not wise economically, if later in the year

Figure 1. Nutrition Education: Lesotho.

Figure 2. Nutrition education in Ethiopia. A mother helps to teach at a demonstration center.

some must be bought back at a higher price. Mothers in urban areas should be given guidance on how to budget their money and how best to spend what is available for food.

Traditional pots, clay or iron, should be used for cooking demonstrations on a stove or stones with whatever fuel is normally used. Stainless-steel pots or sophisticated stoves are unrelated to the mothers' home circumstances. Families and communities should be encouraged to build on and extend the best features of their own way of life.

If diarrheal diseases are common, teaching should emphasize the hygienic aspects of handling food. Care of feeding utensils, storage of raw, prepared, or preserved foods, and the control of animals that might wander into the house must be included. If a vitamin deficiency is common, stress should be given to using foods that contain it.

In many places, supplementary foods are distributed to mothers and preschool children. The distribution center usually is a clinic, which should use the foods as part of the education program. Mothers should be taught why and how to use the rations, particularly if some of the ingredients are unfamiliar. Such teaching is even more effective if the mothers can taste the cooked product at the end of the demonstration.

Results of teaching can be tested by inviting a mother to repeat a demonstration for others at a later session. Follow-up teaching can be done informally during home visits as part of the preventive plan. Education need not always be in groups; it can be conducted informally with an individual at home, in or out of a clinic, or at some other meeting place. Examples set by auxiliary or other health workers can themselves be a continuation of teaching.

Teaching aids. The choice of teaching aids should be highly selective; their use is primarily to reinforce the points being taught. Posters are not helpful if they are used only as decorations on clinic walls. To be really effective, they must be designed with great care, using symbols that can be part of a lesson and cannot be misinterpreted in a specific community. One really good poster can be a link that connects the teaching done in all the clinics. The size, color, and contrast of the pictures must have a direct connection with the local situation and available foods. Good pictures or photographs may be understood more easily than line drawings, and they can be used if it is not practicable to have real food at the lessons. Printed materials obviously are of use only if they can be read and understood.

Flannel boards (bulletin boards covered with flannel on which felt figures and letters can be stuck) can be successful because

mothers and older children can participate in using them. Films and film strips are helpful if the audience is accustomed to mechanical devices, but too often attention to the lesson is distracted by the movement and color.

Whatever the aid used, it must be a specific part of the lesson and be included in any discussions that follow. At each class mothers should be reminded of what was taught at previous sessions, and any education program should be followed up in order to judge its success. If results are disappointing, the general approach to the mothers and the teaching program should be reconsidered and replanned.

What to teach: for the infant. Traditionally and instinctively the majority of infants are fed breast milk on demand for the first few months of life. There are very few reasons why a baby should not be breast-fed and, in many circumstances, survival depends on it. Encouraging the continuation of breast-feeding for at least the first year of life is recommended strongly, particularly if the infant is liable to be weaned, as so often happens, onto a protein-poor diet. Breast-feeding can be continued on demand when the mother works in the fields, at market, or even at some light industry in the local village community, but it is not as easy to do in the towns if the mother is working regular hours, especially if no day-care center is available. Under these circumstances, the infant probably will be left at home with an older sister or grandmother. Breast-feeding should be encouraged for the morning and evening meals but, while the mother is away, particular care must be taken to feed the infant suitable meals with adequate fluids, using clean, safe water.

At the age of about four to six months, the amount of available breast milk cannot by itself supply all the energy the growing infant needs. As a consequence, supplementary nutrition must be provided. (Discussed in other articles).

The importance of hygiene cannot be overstressed. Food mixtures cooked into a pap or porridge and fed with a spoon from a clean cup or bowl are preferable to those given from a bottle, which is difficult to keep clean. Another dangerous, unhygienic method is feeding from the mother's hand, which should be vigorously discouraged. A traditional way to prepare food for infants is for an adult to chew it first. The practice may help to give the baby a softer carbohydrate food, but this small advantage must be weighed against the dangers of transmitting infections to the infant and underfeeding it.

Fats, oils, or sugar can add new flavors to a meal; they also reduce bulk. Improving palatability and increasing nutritional content per unit of food weight can result in better nourished infants.

For the young child. By tradition, the young child shares the adult family diet after breast-feeding ceases. By then he has teeth and is more than ready to chew food. The beneficial nutrient effects of adding vegetables or oil to a mix are great. [See also the two preceding articles.]

The number of times the child eats each day and his share of the family meal depends on when and how it is distributed in the home. Sometimes he eats from his own bowl or plate, but he may have to share a larger dish with older family members. In most places, the main part of the meal is provided by the staple food. This is accompanied by a side dish, such as a stew, sauce, or soup, which usually contains most of the meal's protein because its ingredients include meat, fish, or beans. Therefore, it is important that the growing child gets a fair share, for a child's requirement for good protein per kilo body weight is higher than that of the parents. Unless special care is taken, the child's portion of fish or meat, eggs, or beans may be very small. In many societies, it is traditional for the father and the older male members of the family to eat first and take the best, usually the protein-rich parts of the meal; the women and children use what is left to flavor the bulkier staple food. A child between two and three years of age can be at a further disadvantage, because supplies of breast milk might have ceased, so intake of food depends entirely on what the mother thinks he should have.

The number of meals available for a young child each day is a prime concern. If the adults in a household do not eat three meals a day, provision should be made for the child to eat frequently. He may be given snacks of food left from the previous meal and carefully stored, some fruit, a beancake, or some kind of drink that provides energy and protein. A guide to the adequacy of the food intake will be the child's record of regular weight-gain and general alertness.

Between the ages of one and two, a child may not be able to manage the complete adult diet, and mixtures or meals suitable in both energy and protein value, as well as in consistency and bulk, can be provided without excessive extra preparation. These meals can be made from ingredients that are available locally, are inexpensive, and likely to be used in most households as a family food. The preparation methods are traditional in the areas or regions in which the foods grow. At this age, young children often contract measles, whooping cough, or some other infectious disease. If their diet has been adequate, their symptoms usually are less severe than those of underfed children. However, even if sick, the child needs nourishment, and a troublesome cough or a sore mouth makes it necessary to alter the diet. Dry, crumbly foods or hot, spicy meals should be replaced with blander foods. Appetite, too, is affected by infection, and a sick child can be encouraged to eat by offering foods other than his usual intake.

Nutrition Rehabilitation Units

In addition to the strictly preventative components of a child nutrition program, there must be curative components. These will include hospitals and clinics for the seriously sick, but they can also include units for supervised care of children by their mothers when they are less seriously ill. Such nutrition rehabilitation units supply instruction to mothers and the foods needed for a proper diet for children suffering from nutritional deficiency who need special attention but not hospitalization. Many such units have been started in developing countries in the last few years.

The basic aims of these units are to achieve nutritional rehabilitation for the children and, at the same time, to educate the parents, especially the mothers, in the feeding and care of children in an improved home environment. A specially trained auxiliary is likely to be in charge. She should be capable of giving health education talks to show how nutritious meals can be prepared from locally available supplies, how much the child should eat, and how often. A mother is always responsible for feeding her child at these units; some of the time she will be given direct supervision while preparing the meals. This is part of her training, and the task is to persuade her that similar meals can be prepared easily at home, at low cost, and at the same time as the "family pot." Primarily, she must be made aware that good meals are the only treatment her child needs.

The recommended mixes the mothers will be asked to prepare and feed their children should be based on their own local foods, available within their budget, and related to any specific nutritional problem in each area. Nutritional recipes should be formulated by the auxiliaries, and it is recommended that they be tried on a few children in one or two meals daily. A great deal can be learned from such trials--for instance, how the children like it; whether the stools change in smell, frequency, or consistency, which the mothers may notice and complain about; how much food can be given at one time; how long it should be stored before it spoils; and so on. The children who are given the food should be supervised closely during the week or weeks it is being tested, so other mothers can be informed about the children's reaction to the new mixtures. The basic food in any mix should be a local cereal supplemented with one of the other foods easily obtainable in adequate quantities. If other supplementary foods are available through a clinic or distribution center, mothers should be shown how to use these to the best advantage, but it is not advisable to let them become too dependent on expensive imported supplies.

If mothers of infants or young children who already have recovered through nutritional treatment only can assist or participate in the talks and demonstrations, an excellent example is set for the mothers.

Day centers that include a residence are the best settings for such a plan. The resident mothers can participate either at the centers or in the nearby outpatient facilities, for their teaching is often more effective and persuasive than that of nurses or other "white-coat" staff members. Fathers also should be encouraged to visit and join in activities at the residential center.

It is hoped that a mother who is discharged with her recovered child will go back to her village convinced of the value of the feeding pattern she adopted in the center and that her knowledge of improved feeding will be a good influence in her own community. Sometimes it is useful to award such a mother a diploma for what she learned during the course of her child's rehabilitation and applied afterward at home. The diploma might have photographs of the child and mother on admission and again at discharge; such "before and after" evidence can be impressive.

Rehabilitation units usually are located close to a hospital or a health center. The buildings are simple. Some are mud houses, but with various improvements that are within the means of most local families. Some have such amenities as a raised fireplace, a soak pit, latrine, or compost heap. Some have a vegetable garden or a simple arrangement for raising poultry and producing eggs for the center. It is worth noting that the expense of running a nutrition rehabilitation unit is comparatively small; the cost per child per day is only a fraction of the cost for a patient in hospital.

[Extracted from Chapters 8 and 13 of Manual on Feeding Infants and Young Children, 2nd edition, pp. 71-84 and 113-118. Published by the Protein-Caloric Advisory Group of the United Nations System, New York, 1976.]

Note: This manual is available in English, Spanish and French editions, and can be obtained from local offices of WHO, FAO or UNICEF, or from FAO Headquarters, Via delle Terme di Caracalla, Roma, Italy. A 1981 edition of the manual is currently being prepared.

Community Awareness: A Strategy for Attacking the Problem of Child Nutrition

Save the Children Federation, Inc.

[Programs to combat rural child malnutrition can only succeed where community members are ready to take action on a sustained basis themselves, and believe this is possible and potentially effective. Actions by outsiders to the community, however well intended or enlightened, cannot substitute for this community endeavor.]

The presence of malnutrition and its inhibiting effects on human growth and performance point to the need for concerted efforts towards the prevention and management of this problem. It has become increasingly evident that the active involvement of communities, their perception of the problem and their subsequent participation in its solution, are critical to success in overcoming malnutrition.

Save the Children Federation (SCF), a non-profit voluntary organization working overseas on community development, has been concerned by the lack of community involvement in the identification of child nutrition and health problems and in the planning and implementation of solutions. Villagers are individually aware of nutrition problems; but they are neither discussed nor acted upon by the community as a whole. Even the best community workers, whether foreign personnel or local nationals, have difficulty discussing health and nutrition with villagers. With this in mind, the following strategy has been developed to assist field workers in leading communities and community leaders into confronting and trying to deal with health and nutrition problems and their solutions.

Composed by the Health/Nutrition
Staff of Save the Children Federation,
Westport, Connecticut, with Tina
Sanghvi, Consultant.

This community awareness strategy was originally developed in Pespire, Honduras. It was later adapted and field tested by SCF in villages in Bangladesh and Indonesia. Results of the approach have been encouraging, although not conclusive, and the program outlined here does not represent the only approach to creating community awareness of local malnutrition.

The purpose of an "awareness program" is to make a community so concerned about malnutrition that they will want to organize a good program to fight it. Why does this usually not happen? Villager responses to queries about the problem are often like this: "I know that many children in our village are sick, too thin, or don't get enough food. But what can we do? It is because they are too poor;" or "It has always been like this." Yet, nutrition experts know that children can be saved from dying of malnutrition without a lot of money, and that poor people can help themselves. Perhaps the following are reasons for such answers:

The community may not really know how serious the problem is. They have become accustomed to seeing a few thin or swollen children and have seen them die young, and they may understand the causes in a very general way. But they do not realize that many more children are less visibly affected, and that the malnourished children who survive cannot work as hard or earn as well when they become adults, that their intellectual capacity can be impaired and that they become ill more easily.

In other cases the community may realize that malnutrition is a serious problem and would like to help, but the people think that they are unable to do anything because it will take too much money, special foods or medicines, or because it is "God's will" and cannot be changed. However, the causes of malnutrition can frequently be attacked and substantially reduced without spending a lot of money. Mother's milk is the best food for young infants, and should be continued as long as possible. Much disease can be prevented by boiling all drinking water, by scrubbing hands and raw foods before feeding them to young children, and by safe disposal of excrement. Immunizations are also important in preventing disease.

If a community is not organized to join together and help fight malnutrition, activities such as improved water supply, latrines, and the training of community health workers cannot be well run. In many villages there are attitudes like those reflected in the following statements: "If this child is sick and malnourished, it is the family's job to do something about it. Why should I be concerned?" or "His mother is not a good woman, his father is an alcoholic or doesn't work." In order to effectively combat malnutrition, the community must recognize the condition as being everyone's problem, not just that of a few families with sick or very thin or swollen children.

For each obviously malnourished or ill child, there are at least ten others who are in danger of becoming very sick even though they appear to be healthy now. Further, any community that has malnourished children will also have malnourished adults. It is only because children grow so rapidly and food deficiency shows up so quickly that we often forget the adults whose energy is drained by inadequate nutrition, prohibiting effective work and causing rapid fatigue. Statistics show that a malnourished person dies younger than a well-nourished person. People live much longer in communities that have good drinking water, basic health services, safe methods for disposing of excreta and where the children are fed mother's milk for an adequate length of time. So malnutrition should be a concern for everyone, even those whose families appear healthy now. They should take the responsibility to fight it together with other members of the community. A good program requires a joint effort.

In some villages, there may be food "giveaway" programs underway. Unfortunately, these programs frequently have less beneficial effect in preventing childhood deaths and severe malnutrition than is expected. They can create dependencies, and postpone finding solutions to the real problems causing malnutrition. Further, the most needy and sick children often do not come for the food when it is available, and even if they do the food may be shared by all family members at home rather than kept for children in greatest need. In other cases, the distributed food replaces, rather than supplements, the food that the child had previously been given at home. Also children who are always sick with parasites, fevers, or frequent loose stools lack the appetite to eat as much as they should. Food giveaway programs may be effective short-term answers, but by themselves are not enough; only when combined with good child care practices and good sanitation in the home can they effectively combat malnutrition.

People must help themselves in giving their children proper food from whatever is prepared for the rest of the family, and extend breastfeeding for the infants. They must make efforts to construct and--most important--to maintain and use latrines, sewers and a safe supply of drinking water. These things cannot be done on any sustained basis by outsiders to a community. Outsiders can, however, facilitate the awareness of need, and help initiate remedial actions. The orientation program that follows is intended to help a community to understand this, and to focus on creating programs which really work in helping malnourished children and mothers to become strong and healthy.

Method

The facilitator. The heart of the proposed strategy for stimulating community awareness of child nutrition problems is a kind of community worker we will call a "facilitator." Such a person could be

either a foreigner or a national employee of a private voluntary organization such as SCF, or employed by the national government; the discussion here assumes the former situation. The facilitator's function presumably should be combined with other work which would bring the worker into the rural community. The facilitator must have sufficient knowledge about nutrition and health subjects to guide villagers, but need not be a high-level professional. He or she must also be skilled in communications, in approaching villagers in ways appropriate to them and gaining their confidence, and in stimulating actions that will not be dependent on the facilitator's continuing presence but will endure after his or her departure.

The facilitator's role initially is to encourage community groups to talk about malnutrition. This role calls for a lot of imagination and flexibility, and should not be performed in any rigidly defined way. The facilitator can assemble people and talk to them about the prevalence of malnutrition and what can be done about it, but this will hardly suffice. Villagers, like students in school, may listen quietly and nod their heads in agreement, but with less than full comprehension and even less feeling of participation; respectful manners are of less value than lively, perhaps impolite concern. Facilitators must find what people are concerned about, and build on that into the subject of children and their condition. People should be encouraged to relate their children's experiences; in time, villagers should begin answering each others' questions, with the facilitator amplifying or supplying technical points. The facilitator can highlight the important conclusions after they emerge.

Group discussions will become more meaningful for eliciting community action than talks with individuals or families. Facilitators should develop various ways of leading such community groups, e.g., sitting down with them, not standing before them like teachers with a class. The objective is not so much to teach nutrition as to get villagers to teach themselves, to draw out from them their experiences for group examination. Rather than listing the topics that need to be covered, let us illustrate how one might approach the subject of germs.

Germs in the surroundings. Where do germs live? They live in the air breathed out by sick people; in unclean, unboiled water; in the dust and dirt where people defecate and where garbage is thrown; in houses where animals live too near the people and where there is not enough ventilation; in raw, unwashed foods; on unwashed hands and feet; and on flies. At this point in the discussion a supportive illustration would be useful. The following simplified story could serve as a basis with variations added to make it more relevant to the local conditions.

"Listen to what happened to little Maria. Her mother already had five children when she became pregnant with Maria. Her youngest child was then only eight months old.

"Her mother felt constantly tired and could not care for the other children. She didn't eat enough because after her husband and other children were fed, there was not much left for her. The neighbor who was also pregnant went to the feeding program center and received extra food, but Maria's mother who needed it more because she was so thin and weak didn't have enough time to go there and wait.

"Two months before Maria was born, the youngest child came down with a high fever and suddenly died. Maria was born thin and pale and her mother had a low fever for many days afterwards. Her husband had to take her to the doctor in the town several miles away and buy expensive medicine. When she felt better, she was able to feed Maria breast milk.

"Maria became healthier and fatter--she was putting on weight, getting heavier and seemed to be growing well. Then at about four or five months her mother gradually stopped breast feeding Maria and started giving her cow's milk with sugar in it.

"Maria did not drink enough of this and in one month started to look thinner and became pale. One day her mother went to the market on her weekly visit. Before leaving she told her five children that she had prepared some food for them that she had left on the mat. She told them that she might be late and to go ahead and eat their food. It was a very hot day and flies which had spent the day walking around on the rubbish heap flew inside and rested on the food. Their feet were sticky and dirty, and as they hopped over the food they left tiny germs which the children could not see but which cause disease. The children came to eat their meal. They were very hungry and ate up all the food which was then covered with tiny germs. Maria, a weak and thin little girl, stuck her fingers in the food and sucked at them happily. Her older brother gave her some water from a jar filled from the nearby well.

"During the night, Maria woke up and began to cry. She seemed to have pain in her stomach and her stool was very loose. She defecated several times during the night and in the morning was very miserable. Because her mother believed that children become sicker if they drink or eat during an illness, she starved Maria. For the next day or two the little girl, already thin and frail, looked sad and developed sunken eyes; her skin became dry, loose and creased like paper.

"But they did not take her to the doctor until it was almost too late because the town was far away and the father was busy harvesting. Besides, they did not have enough money until the harvest was well underway."

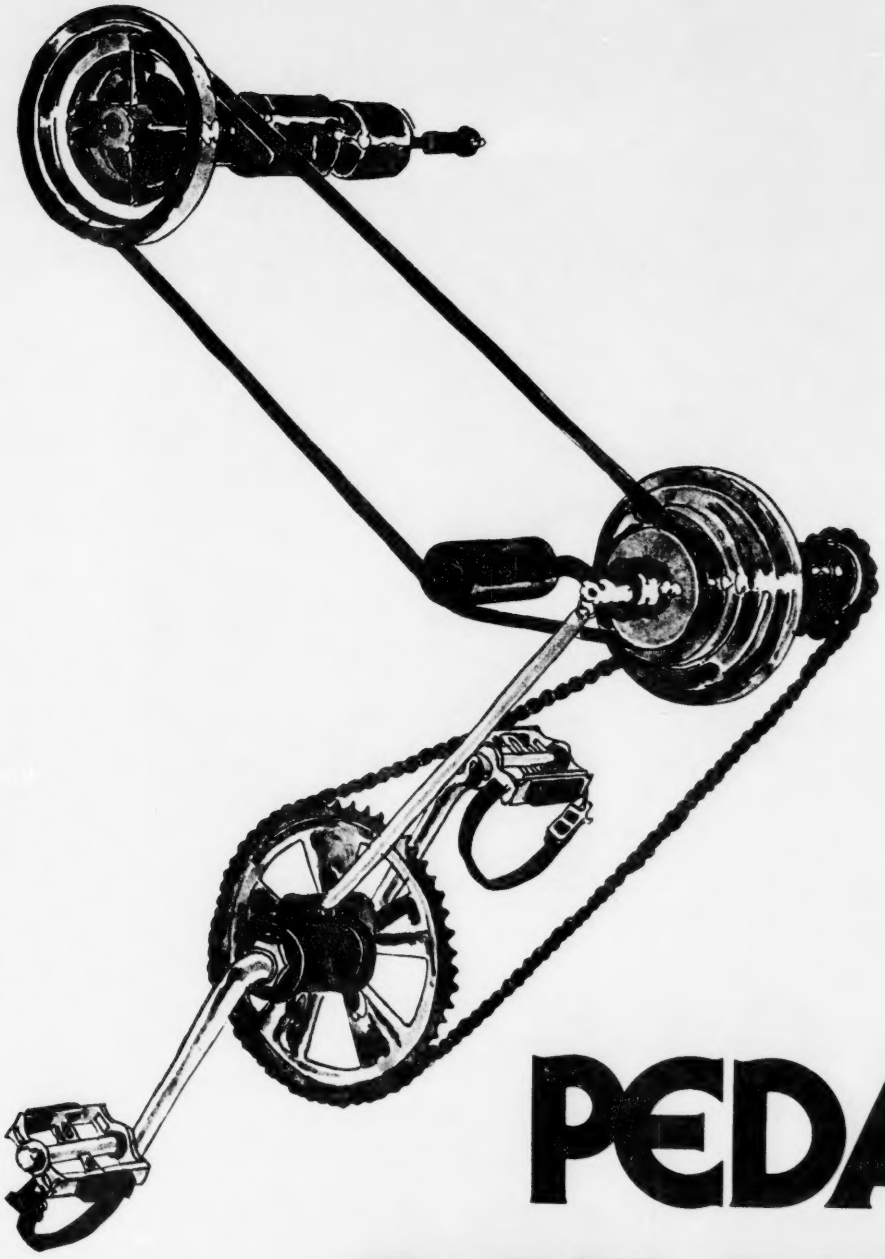
Follow-up. After this or a similar simplified story, the facilitator should elicit responses from the villagers through questions like: What things made Maria come so close to dying? The facilitators should probe for responses like: her mother was weakened by having several children too close together, so that Maria was born without sufficient strength to grow and fight germs; she stopped breast-feeding Maria too early; and the cow's milk was not boiled to kill the germs in it before giving it to the child.

Further responses might include: the children defecated near the house and there was garbage on the ground nearby so children playing barefoot would pick up germs. These practices also attracted flies which carried germs to areas near the house; the water for drinking was not boiled; the food was left uncovered so flies could walk on it; no water was given to Maria when she was losing water through diarrhea, so she became dehydrated; and they did not give her medicine early enough to stop the sickness from almost killing her.

After identifying the problems, throw out a question that would elicit potential solutions like: What could the family have done? The facilitator should then probe for responses like: more space between children; continue mother's milk for up to a year or more; give cow's milk and other foods after five or six months; boil water and milk before drinking; keep foods covered from flies; use latrines; keep the rubbish heap covered with earth and away from the house; give food and water to children during sickness; and give the sick child medicine as soon as he/she gets sick.

At this point, the link between the community and the problem of malnutrition might be made. In order to do this the facilitator might ask a question like: What does the community need to do? Probing for responses like these would be beneficial. The community should: bring medical services to the village (some members can be trained in basic health care and can also help educate the mothers in proper child care); build latrines; provide safe drinking water; provide safe methods of garbage disposal; make sure that the really needy families can get food easily, if there is a feeding program in the village.

[Adapted from "God's Will or a Community Problem? A Community Awareness Strategy for Understanding the Problem of Malnutrition." Unpublished manuscript, 1980.]



PEDAL POWER

POWER UNIT DRIVEN BY BICYCLE PEDALS.
(ILLUSTRATION: RODALE PRESS)

Harnessing Human Energy: Pedal Power and Transportation

Stuart S. Wilson

[Bicycle technology shows great promise as a reasonable means to help meet goods and human transportation demands in the face of rising petroleum prices, urban congestion and a shortage of motorized vehicles. The following article discusses how this technology might be improved.]

It is arguable that the most important technical development in the nineteenth century was the bicycle. Pre-bicycle transportation technology was heavy and inefficient--typically the steam locomotive--but post-bicycle technology became lightweight and efficient, both structurally and mechanically. The lightweight tubular steel frame, wire-spoked wheel, bush roller chain, ball bearings, and pneumatic tire, developed specifically for the bicycle, all led to a triumph of matching machinery to the human body, which contains why the bicycle has succeeded so widely in providing cheap and effective personal mobility worldwide.

The bicycle is extremely energy efficient in that it uses the most powerful muscles in the body--the thigh muscles--in a circular pedaling motion, 60-80 revolutions per minute, and then transmits the power efficiently by means of a sprocket-and-chain mechanism and ball bearings. The torque, or turning effort, exerted by the feet on the crankshaft and therefore on the sprocket and chain is not constant, being appreciably smaller but not zero at the top and bottom positions of the pedals. This minimum torque is achieved partly by "ankling" (tilting the top foot upwards and the bottom foot downwards), partly by friction of the shoes on the pedal rubber, or by the use of toe clips.

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The minimum torque varies with individuals but is of the order of one fifth of the maximum. On a bicycle this variation has little effect because of the inertia of the rider and machine; but if we consider driving a stationary machine, for example a pump or a corn grinder, then the motion becomes jerky and it is desirable to even it out, either by incorporation of a flywheel or by other means, such as the use of an elliptical sprocket, which in effect varies the gear ratio twice during each revolution of the crank.

How much power can we expect to be able to supply by pedaling? Tests done under laboratory conditions do not relate too well to experience on the road; but tests at Oxford on a bicycle with a built-in dynamometer confirm that 1/10 horsepower or 75 watts is a reasonable figure for the sustained output of an average rider at a road speed of 12 mph. On the other hand, 1/4 horsepower, or nearly 200 watts, is produced at 18 mph, which many riders can achieve at least for a limited time; and up to 1 horsepower or 750 watts is possible for a second or so.

These figures reveal a remarkable overload capacity of the human body--the ability to exert 10 times our normal output when required. The question is how to apply this muscle power to useful ends. In addition to personal transport, as with the usual bicycle, how can we develop the means of helping people to help themselves in other ways by their own efforts, without depending on expensive petroleum?

Figure 1. Bicycles remain a popular transportation vehicle in many countries.

Goods Transportation

Let us consider extension of bicycle technology to goods transport. The carrier bicycle with a large basket over the front or back wheel is effective for loads of up to 100 lb. or so (Figure 1). Beyond that, however, three wheels are better than two (Figure 2). Three-wheeled vehicles have been in use since the nineteenth century, but have evolved only slightly. A recent attempt to rethink the design is shown in Figure 3. It was designed by the author and built at Oxford with support from Oxfam. Named the "Oxtrike," it is designed as a basic chassis with a choice of bodies to carry a variety of goods or people up to a payload of 330 lbs. or 150 kg [see also Development Digest, October 1978, p. 80]. It incorporates a number of novel features in order to overcome some of the limitations experienced with existing designs of cycle rickshaw (pedicab, becak, or trisha) in current use in India, China, Indonesia, and Southeast Asia. Although a variety of designs have evolved in these different locations, there is little evidence of radical redesign in order to improve performance.

Figure 2. Tricycle used for transportation of goods in Taiwan.

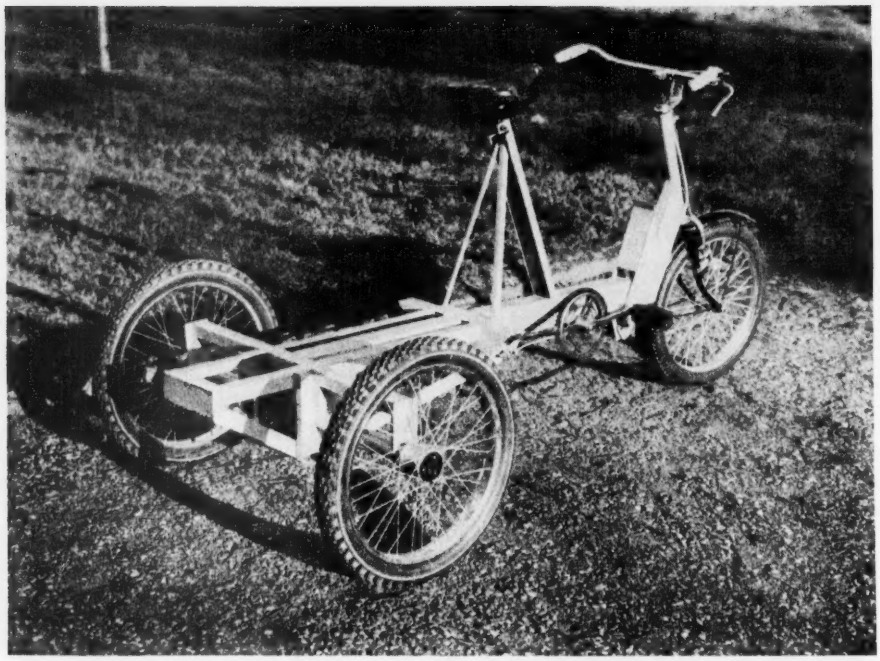

Figure 3. Oxtrike chassis.

The main defects of existing designs include the use of only a single gear ratio which is often too high, so that starting on the level or climbing a gradient imposes a severe strain on the driver; usually only one wheel is driven, while braking also is confined to one wheel--a dangerous defect. The use of standard bicycle parts often results in insufficient strength for the far greater loads imposed, leading to the collapse of wheels or forks unless specially strengthened. The frame itself, of tubular construction on bicycle lines, is a less than optimum design with regard to its strength-to-weight ratio.

Despite these defects, various types of tricycle have established themselves widely in Asia, though not in Africa or Latin America, although they are fighting a losing battle in some of the bigger cities such as Singapore and Jakarta. Some authorities wish to banish them on the grounds of lack of safety, causing congestion, and lack of a modern image. To abolish such a useful, low-cost, low energy, low-noise, and low-pollution vehicle would deprive the poor and middle classes of a most effective means of transport, and cause unemployment among drivers and associated trades.

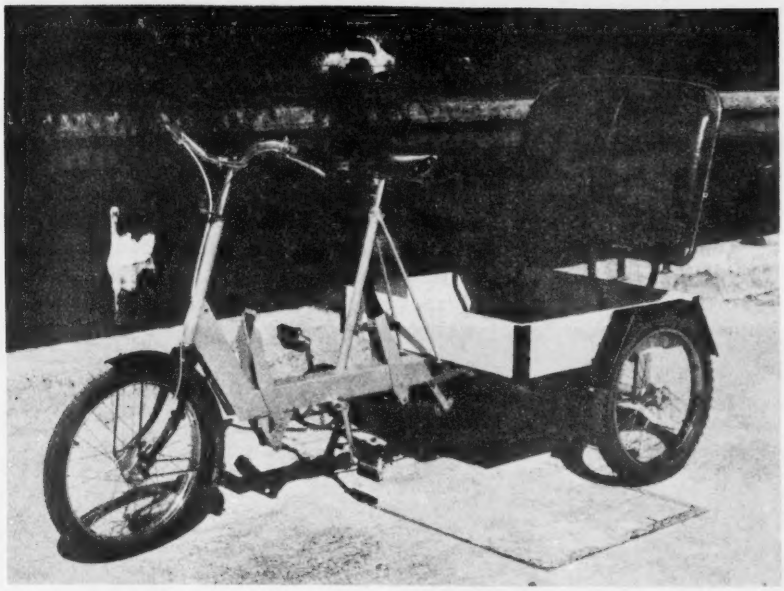

Figure 4. Oxtrike with temporary seat.

Since the tricycle holds exciting promise for both developing and developed countries alike, it seemed worthwhile to rethink the design with a view to maintaining or extending tricycle use. The Oxtrike overcomes five of the major problems in standard tricycle design:

1. Stronger wheels with smaller diameter have replaced the larger standard types. In addition to strengthening the vehicle, this change provides the added advantage of lowering the center of gravity and thereby increasing stability.

2. A three-speed gear box has been incorporated into the transmission system, improving the driver's ability to start with a heavy load and to climb at least a slight gradient. This greatly improves the vehicle's range and mobility.

3. A more extensive braking system has been installed with a hand brake for the front wheel, pedal brakes for the rear wheels and even a parking brake for use when the trike is not in motion.

4. Construction from standard square steel tubing and other materials not requiring special treatment makes Oxtrike manufacture far less complicated. This enables fabrication of the trike by local small-scale industries.

5. The variety of bodywork types available in the Oxtrike allow for numerous uses of the vehicle. A seat for two passengers (see Figure 4), a box for goods, a hopper with sloping ends for loose material like sand, or even a 40-gallon drum to carry liquids are added features from which the driver may choose.

[Extracted from Chapter 2 of Pedal Power, James C. McCullagh, ed., pp. 37-56, Copyright © Rodale Press, Inc., Emmaus, Pennsylvania, 1977.]

Note: This publication is available on request from VITA, 3706 Rhode Island Avenue, Mt. Rainier, Maryland, 20822 U.S.A.

Harnessing Human Energy: Stationary Pedal Power

Michael R. Whiteman

[Potential uses of pedal power extend beyond the transportation methods described in the preceding article. This article discusses and illustrates some non-transportation pedal technologies and how they might be applied.]

With present fossil fuel costs and energy availability problems in both the developed and developing worlds, other energy sources must be considered and tested. One such source is as old as mankind itself; human energy as expressed through pedaling. Human energy can be harnessed through pedal power for tasks such as shelling maize (See Figure 1), operating a winch (See Figures 2 and 3) as well as a variety of other common tasks that generally require either electric power or a gasoline motor. Pedal power can be mobilized with an apparatus connected to a bicycle, as shown by the arrangement in Figure 4 which generates electricity. The pedal apparatus can also be built into the particular machine that it powers, which limits it to only one function; or it can be built as an independent apparatus and attached to many different devices. Such an independent unit might be likened to a power drill with many attachments, e.g., a screwdriver attachment, a sanding attachment, a grinding attachment, a polishing attachment in addition to drill bits.

Figure 5 shows an example of such an independent unit. Called a "primemover," it uses the basic bicycle design, but the chain driven by the pedals powers a pulley wheel instead of bicycle wheels. The

This article was composed by Mr. Whiteman, Associate Editor of Development Digest, with materials from Pedal Power.

Figure 1. Pedal power providing energy to a corn sheller.

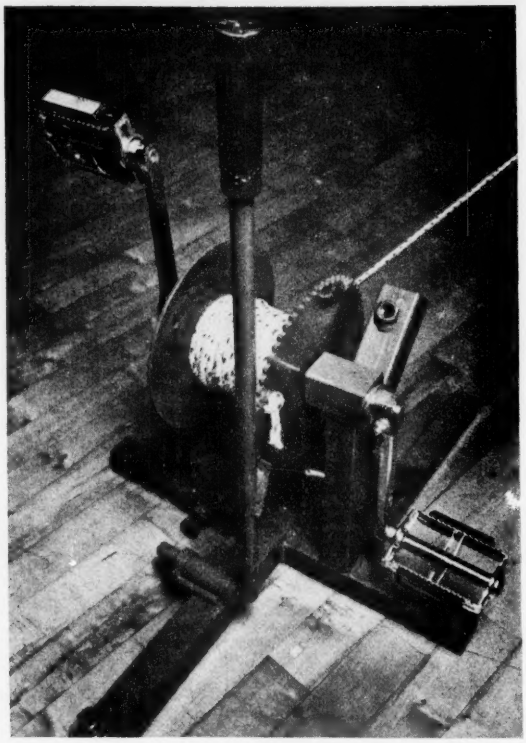

Figure 2. Close-up of brake handle and metal extension that wedges against the teeth of the sprocket to brake the spool.

Figure 3. The winch is a two-man operation.

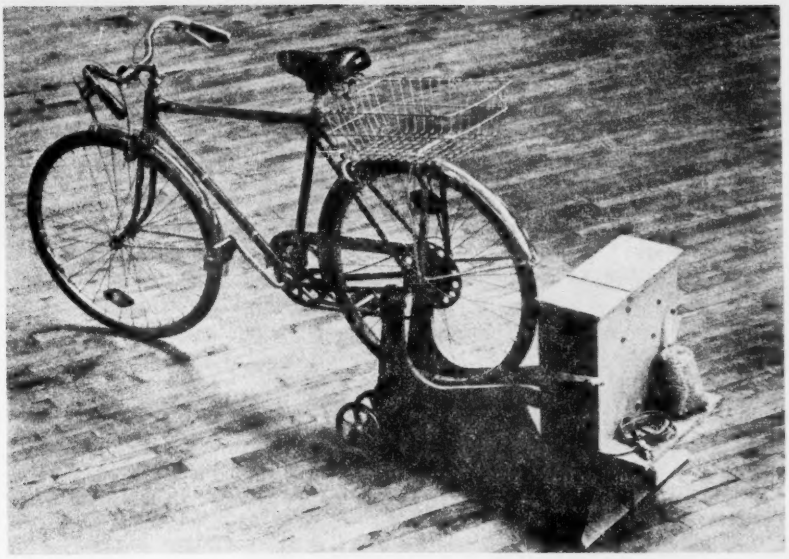

Figure 4. The Bik-O-Generator, manufactured by Homestead industries, will power a grain mill or generate electricity. A pulley attached to a power takeoff wheel could be attached to many other belt-powered tools as well.

Figure 5. Pedal-driven primemover.

pulley is attached to one end of the drive shaft, and a flywheel is attached to the other (See Figure 6). This flywheel, in the weight range of 25-30 pounds, provides sufficient inertia to carry the mechanical operation through high speed torque requirements and thereby evens out the inconsistency of pedaling.

The primemover can be attached to any pulley-driven apparatus by using a transmission belt. By varying the sizes of the pulley wheel on the driveshaft and that on the driven machinery, a range of different speeds can be obtained which greatly increases the applicability and versatility of the primemover as a power source.

The primemover could be constructed from a standard bicycle frame. The one pictured in Figure 5 was made from an AMF "Whitely" exercise cycle. The bicycle wheels must be removed and extensions must be added at the base to stabilize the frame as is shown in both Figures 5 and 6. The driveshaft can be constructed with varying sized sprockets attached to produce the desired output speeds and gear ratios. The flywheel can be constructed by filling a cast-iron sheave with concrete to obtain the desired weight. Appropriate transmission pulleys are available in most hardware stores in various sizes.

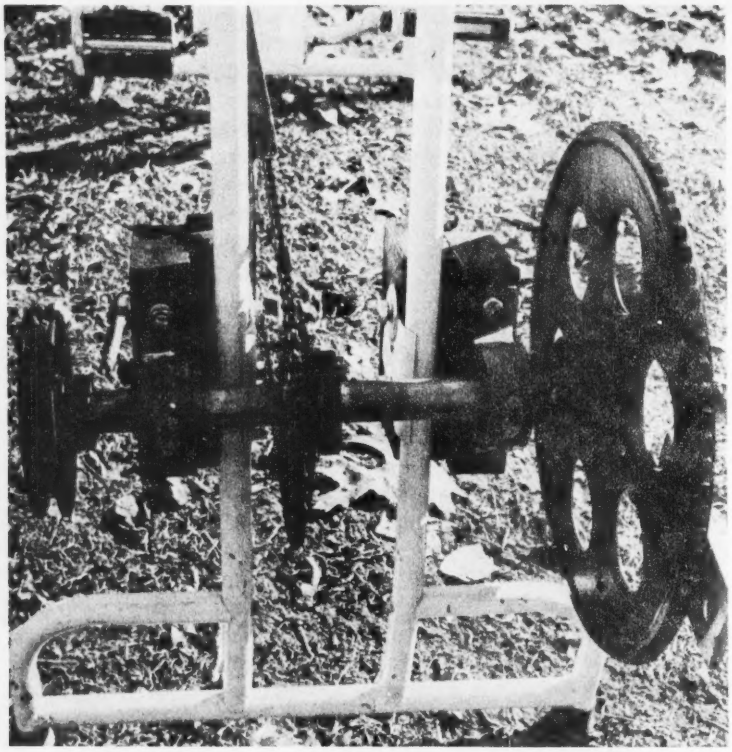

Figure 6. Close-up of drive assembly and flywheel from the primemover of Figure 5. Pulley wheel is on the left, flywheel on the right.

What can the primemover do? It can be attached to saws, pumps, churns, electrical generators, hydraulic units, and lathes (see Figure 7) just to list a few. The possibilities for the primemover are basically limited only by the extent of the user's imagination.

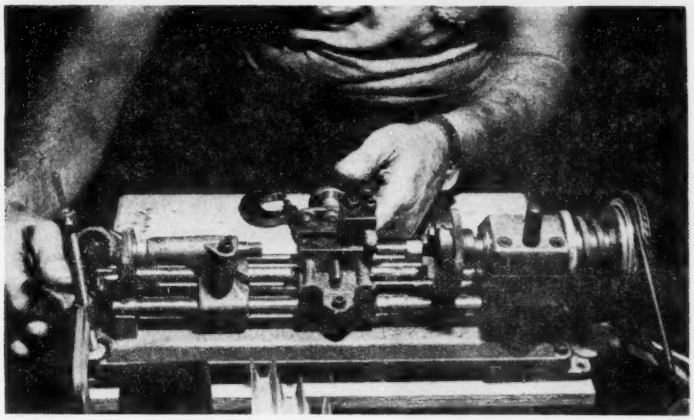

Figure 7. A lathe, one of many machines that could be driven by pedal power.

Another major area of need that can be addressed by stationary pedal power is water pumps. In regions where there is little petroleum available for deisel or gasoline-powered pumps, or where the costs for such pumps and fuel are prohibitive, human power can be substituted. A foot-powered pump developed by engineers at the International Rice Research Institute in the Philippines can lift large quantities of water several feet using only moderate amounts of labor. The operator simply stands on two foot rests at either end of the pump and rocks back and forth. That effort compresses a diaphragm which forces water from the outlet valve into the field being irrigated. By operating the pump in a rhythmic manner, a continuous flow of water is pumped (see Figures 8 and 9).

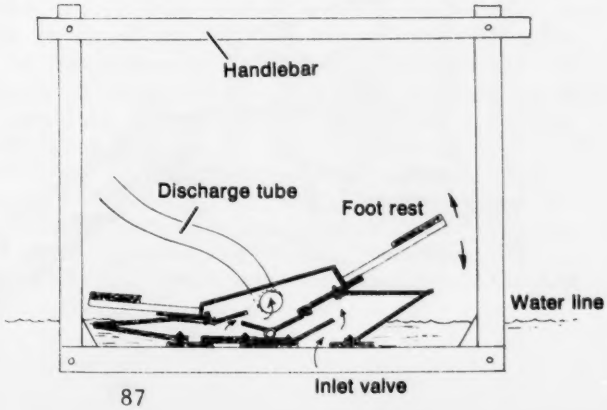

Figure 8. Schematic drawing of a bellows pump.

Figure 9. Foot-operated Diaphragm pump developed by the International Rice Research Institute.

Other designs for foot-driven water pumps are possible. Figure 10 shows a modified bicycle frame model capable of lifting water from a river or stream up to an irrigation channel. This pump could be used in the same situation as the bellows pump just discussed. The pedals chain and sprocket in the bicycle frame are used to drive an Archimedes screw, or auger, submerged in the water. The rotation of the screw lifts the water to an outlet several feet above the surface of the river and could either dump it into irrigation ditches or into a pipeline for use elsewhere.

Figure 11 shows a pedal-powered pump designed for boreholes or wells. Again the basic power mechanism is simply a bicycle frame. The tire has been removed and the rim drives a loop of chain onto which either rubber washers or balls are attached at regular intervals. The chain runs through a tube extending into the well, and when the operator pedals the bike the tightly fitting balls or washers lift water trapped between them to the outlet at the top of the well. From the outlet the water is delivered to any sort of catchment vessel desired.

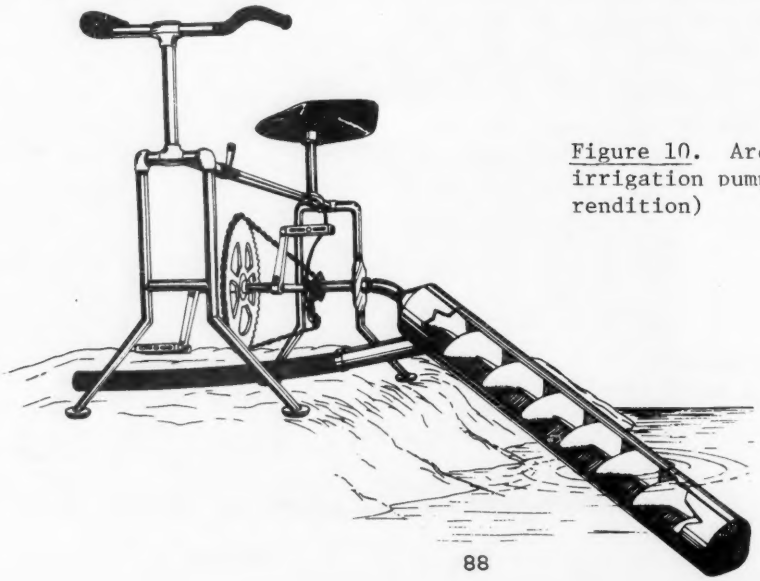

Figure 10. Archimedian-screw irrigation pump (artist's rendition)

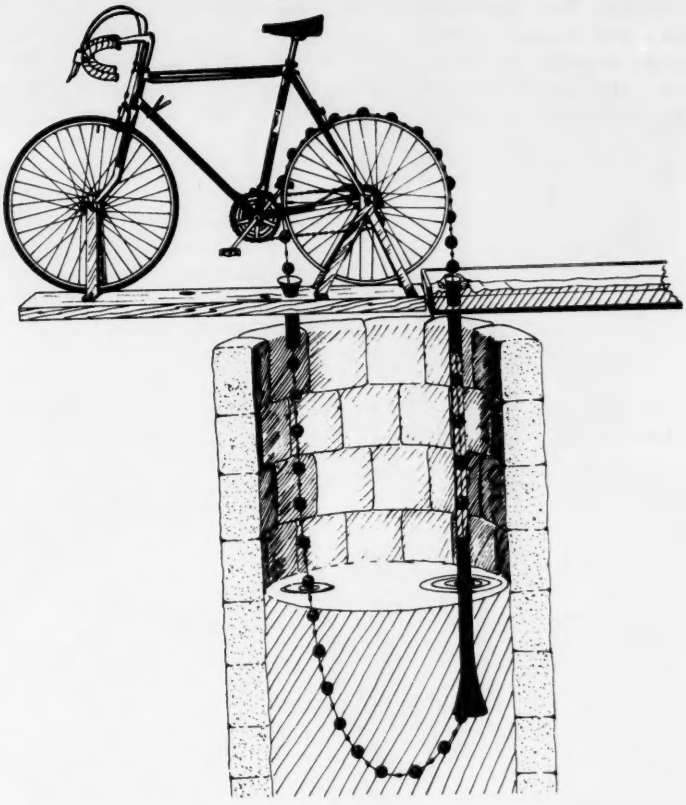

Figure 11. Ball and chain pump (artist's rendition).

This brief listing of possible pedal-driven machines is far from exhaustive. There is considerable potential for the development of more widespread application of stationary pedal power. With the rising cost of fuels, new applications of this technology not previously seen as useful or desirable can be found in both developed and developing countries, for a variety of functions in rural areas lacking electric power, and for certain tasks in urban areas. A major obstacle to such development, however, is the lack of organizations dedicated to the design and testing of prototypes. There is little incentive for commercial firms to undertake such work, since there is no near term financial return as of now. Not insignificantly, the whole idea of solving real problems by simple means--rather than by computers--is foreign to most scientists and research engineers. However, the climate of opinion is changing, and there are organizations like the

National Center for Appropriate Technology, Volunteers in Technical Assistance, and Rodale Press, Inc. in several countries where simple technologies are being taken seriously. With aid from organizations like these, the world should come to recognize that the technological simplicity of pedal power has application for us all.

[Article compiled from materials and illustrations from Chapters 2, 3, 4, and 6 of Pedal Power, James C. McCullagh, ed.]

Note: This publication is available on request from VITA, 3706 Rhode Island Avenue, Mt. Ranier, Maryland, 20822, U.S.A.

DISASTER RELIEF

AFTERMATH OF AN EARTHQUAKE
IN SICILY. (PHOTO: AID)

Planning for Disaster: The Preparedness Dimension in Emergency Assistance

Michael R. Whiteman

[Being prepared and equipped to handle a disaster is becoming an increasingly important function of emergency assistance. Information on disaster-prone parts of the world, and the lessons from experience with past relief efforts, are the essential ingredients of a preparedness program.]

Third World countries, with limited resources to spare, can ill afford the added burden of health problems, rebuilding of cities and villages, food scarcities and the budgetary drain resulting from natural and man-made disasters. Forward-moving development is interrupted, and a dependence upon outside sources of aid can develop. While floods, volcanic eruptions, storms, fires and famine may not be within man's control, the extent of their devastation and the toll taken in human lives often can be. The effects of many disasters can be minimized and the costs of recovery reduced by planning and preparedness measures.

In 1964, the U.S. Agency for International Development created a disaster relief office. The Office of U.S. Foreign Disaster Assistance (OFDA) coordinates all U.S. government foreign disaster assistance, and to a large degree coordinates public and private disaster assistance from the U.S., as well as working closely with international organizations; it also engages in planning preparedness activities, some of which are described below. Through the years since 1964, as a result of the experiences of organizations such as the Office of the United Nations Disaster Relief Coordinator (UNDRO), the League of Red Cross Societies, CARE and others, a great deal of sophistication has been gained in how best to

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provide assistance. The major questions confronting relief organizations to which answers are being sought are the following: What supplies and expertise are most urgently needed in the wake of disaster? How can these supplies and expertise be most effectively delivered and distributed? Is it possible to reduce the devastation of a potential disaster?

Disaster Preparedness in OFDA

Preparedness includes research on potential sources of disaster, predicting the nature of possible disaster, preparing inhabitants of disaster-prone areas in ways to react in case of a disaster, as well as stockpiling goods, and organizing information in various fields to make possible the most efficient response from governments and relief agencies when a disaster strikes. Relief assistance agencies have called upon medical people, urban planners, environmental engineers, sociologists, nutritionists, climatologists, geologists, agricultural specialists and a myriad of other experts to cooperate in pulling together information that might be used in disaster prediction and in advance decisions on the probable appropriate countermeasures, as well as in listing the supplies that need to be stockpiled near the potentially affected region.

The percentage of the annual appropriation to OFDA spent on preparedness measures, though a minority share, has steadily increased over the past four years; and indications are that the trend will continue. This wider view of the scope of disaster-related assistance is supported by consideration of the importance of natural and other disasters in setting back development and economic growth.

Preparedness measures can be taken by two different parties: the assistance agencies, and the disaster-prone countries themselves. In the area of aid agency preparedness, OFDA has developed some interesting programs. Drawing on field information assembled from disaster relief performance, OFDA is attempting to develop a way of determining what can be inferred from experience. The particular activities in a disaster relief effort are analyzed and assessed by degree of success, with reasons given for the results. These judgments are recorded and filed in a retrieval system called "Lessons Learned." This information is cross-referenced in a number of ways, which helps OFDA to avoid the mistakes of previous relief activities when responding to a disaster situation, and to determine what looks to be the best remedy found from the past attempts without performing research. The Lessons Learned system could in time evolve into a useful reference source to assist in deciding such questions as what quantities of which commodities are required to care for what number of people in one particular kind of environment or situation.

Emergency shelter--an example. OFDA has learned from experience that there are some essential factors that must be taken into consideration when providing emergency shelter. Both the errors and the sound decisions made in the past with regard to any aspect of temporary shelter provide the inputs into the information bank. Factors to be taken into account are: how long the temporary housing is to be used, under what environmental conditions it is to be used, how many people will be using it, and what cultural factors such as modesty, male-female interaction, etc., need to be considered. With judgments, opinions and data based on past experience available, more realistic shelters can be provided by taking into account factors such as cost, cultural and environmental acceptibility, and transportability of the final product. Two kinds of action can follow: 1) general-purpose shelters adapted to disaster needs can be stockpiled in strategic locations; and 2) where these general-purpose shelters are not suitable, the particular shelter form most appropriate to a local situation can be ordered promptly when needed.

Using Lessons Learned, AID has concluded that the following factors warranted consideration in supplying temporary shelter for use in emergencies:

1. For the day after the disaster and for several days beyond, it has been observed that disaster victims are willing to accept nearly any shelter that is available, regardless of how crowded and uncomfortable it may be. Living in schools, churches or sharing homes with extended family have been found to be acceptable for this period. This provides time for temporary housing to be dispatched and distributed.

2. After this initial period is over, and if permanent housing is not yet available, temporary lodging should provide a minimum of 20 square feet (two square meters) of floorspace for each family member and should provide some visual privacy. Housing in quarters this crowded will probably remain acceptable as long as it is apparent that permanent housing will be available within a month or so.

3. For a period of longer than a month, at least 25 square feet of floorspace for each family member is desirable.

4. The tent developed by OFDA measures 10 feet by 14 feet, providing 140 square feet of floorspace. This would house a family of six adequately for up to a year, or a larger group for less time. Using bunk beds, a family of eight could live for several months with a minimum

> of discomfort and inconvenience. And all of this is obtainable at a cost of about $75 per person including the bunk beds. Lessons Learned in the past have shown the need for: adequate ventilation; extra long tent pegs for wind resistance and for sandy soil; and tent flies (a second roof above the first) where rainfall is heavy.

Today, stockpiles of 8,000 to 10,000 tents of the kind described are kept in Guam, Italy, Singapore and Panama and can be quickly moved by commercial or military aircraft to any point in the world. They are kept packed and palletized, ready for airlift.

Related activities. Information is also provided for assistance agencies through country profiles, which OFDA is in the process of producing. Thirty-eight have been completed to date. The profiles are relatively exhaustive catalogs of information on selected disaster-prone countries which may be referred to quickly in case of a disaster, or in developing disaster preparedness programs. The profiles contain data on many different conditions relevant to disaster assistance measures--the capacity of airports to receive planes; what local needs are likely to be; what distributional networks are presently in place--or if not in place, how such networks might be set up; local conditions that would make certain supplies inappropriate (e.g., dietary traditions, or climatic and topographical factors); contact lists, and so on. These profiles are updated on a regular basis.

The second half of the assistance equation--helping the disaster-prone countries develop their own preparedness programs--is also being addressed. Regional seminars, technical assistance, and various other measures are increasing the capacity of affected nations to minimize the economic and social impact of a disaster by their own efforts.

The Office of the United Nations Disaster Relief Coordinator (UNDRO), et al.

UNDRO, in addition to serving as a clearinghouse and coordinator for the disaster relief activities of governments and disaster assistance agencies, is also working in disaster preparedness. This organization has developed a series of guidebooks on disaster mitigation, providing the best current information on areas of necessary action in post-disaster situations. In its role as an international coordinator, UNDRO is also mobilizing work on pre-disaster planning. UNDRO, with a limited budget, relies on the specialized skills in the World Health Organization (WHO), the World Meteorological Organization, the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Environment Program (UNEP) and HABITAT for its

Three principles of the United Nations Disaster Relief Organization (UNDRO)

- Natural disasters constitute a formidable obstacle to economic development
- Many disasters can be prevented
- The most basic preventative measures are often the least expensive

development of preparedness plans and strategies. This includes research on the causes of disasters, on their health consequences, and such preventative measures as more disaster-resistant housing and zoning. UNDRO also helps sponsor international seminars and provides technical assistance. The United Nations Development Program (UNDP) representatives in countries around the world usually double as the representatives of UNDRO, thus underlining the link between economic development and disaster occurence. National relief agencies in Sweden, Canada, France, England, West Germany and other countries are also carrying on active work in the areas of disaster assistance and preparedness.

Conclusion. New sources of information for preparedness are becoming available. Remote sensing provides a means of monitoring potential agricultural disaster, as well as disaster-producing storms. Seismological technology is developing to a point where earthquake prediction is coming somewhat closer, and better housing design for quake-prone areas is possible. Information sources like these at the disposal of the international community can contribute a great deal to progress, measured in lives saved and in faster recovery from disasters, with less wasteful or misconceived efforts at remedial action.

[Information on the Office of Foreign Disaster Assistance was provided by Jeffery Clark and Margaret McKelvey of U.S. AID. Information on UNDRO was provided by James Morentz, Editor, Hazard Monthly. Materials on emergency shelter came from Disasters, Vol. 4, No. 1, 1980, pp. 39-44.]

Emergency Shelter

Ian Davis

[Before appropriate building designs or the pertinent guidelines for their selection can be laid down for post-disaster housing, the success or failure of previous emergency shelter programs must be considered. The evidence and conclusions presented here are based on records from seven disasters: earthquakes in Skopje, Yugoslavia in 1963, Gediz, Turkey in 1970, Chimbote, Peru in 1970, Managua, Nicaragua in 1972 and Lice, Turkey in 1975; war damage from 1972-1973 in Bangladesh; and Hurricane Fifi which affected Honduras in 1974.]

> "It is clear that we need to understand the underlying structure of a culture and its relation to the physical forms before we can design. This knowledge must be specific rather than general, both for design and implementation, and open-endedness may be an important consideration. We must study the vernacular forms since they show most clearly the relations between life styles, values and physical form, the relation of social structure to dwellings, dwellings to the larger environment and so on. The traditional housing and settlement forms, and their associated social and cultural patterns, should be seen as the point of departure rather than being ignored."
>
> A. Rapaport, The Ecology of Housing, 1973.

Donor Designs

Past experience shows that the overwhelming majority of shelter and housing systems used in disasters, although sometimes using imported materials, are indigenous designs, locally constructed and often indistinguishable from local housing. Donor countries

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have contributed three other types of design: advanced technology designs, advanced techniques used to modify existing traditions, and designs based entirely on local traditions.

Donor solutions to design problems are a comparatively recent phenomenon, coinciding with the development of aid, rapid transportation and the growing spirit of internationalism. There has been no shortage of proposals. Many ingenious but often impractical ideas emerged from a competition on emergency shelter, held by the International Union of Architects in 1975. Proposals ranged from a floating fishing village of emergency units to projects in: cardboard, pneumatic tubes, canvas, plastic, aluminium frames, fiberglass, sprayed concrete and polyurethane. In sharp contrast to these designs which unquestionably rely on very advanced technology, there was a very thoughtful prize-winning proposal by a group from Carnegie-Mellon University. [See Development Digest, April 1974, pp. 83-90.] They developed a proposal that relied on indigenous materials and indigenous building skills, but used western expertise in devising the proposal. The basic unit is a series of "A" frames made of bamboo which can be extended for varying lengths, with a roof of thatch or leaves (see Figure 1). This concept, field tested in Bangladesh, re-

Figure 1. Bamboo "A" frame housing being built in Bangladesh, designed by the Cuny/ Carnegie-Mellon group.

sults from a very careful analysis of an existing situation which included a study of cultural and economic patterns, local climate conditions, as well as exploring the performance of existing vernacular (local) housing. Thus Rapaport's warning quoted above was followed very closely.

High technology designs. Many manufacturers have products available which they classify as disaster shelters. There are at least 18 international systems of emergency shelter, and over 21 manufacturers of prefabricated houses who are anxious to use their products in disaster situations. However, the response to these designs by both relief agencies and governments has been very small. Reasons for this lack of interest include low relevance of the products to the needs of the situation, and high transport costs. The U.S. Department of Housing and Urban Development commissioned a major study of all manufactured products for disaster relief, published in 1974, which shows a very interesting approach to comparing the cost-effectiveness of housing systems.

The main western "advanced technology" systems which have been adopted are the West German Red Cross Bayer polyurethane igloos--1,400 units have been used in Turkey, Peru and Nicaragua (Figure 2), and the Oxfam polyurethane hexagonal igloos, used in Lice, Turkey where 453 units were produced.

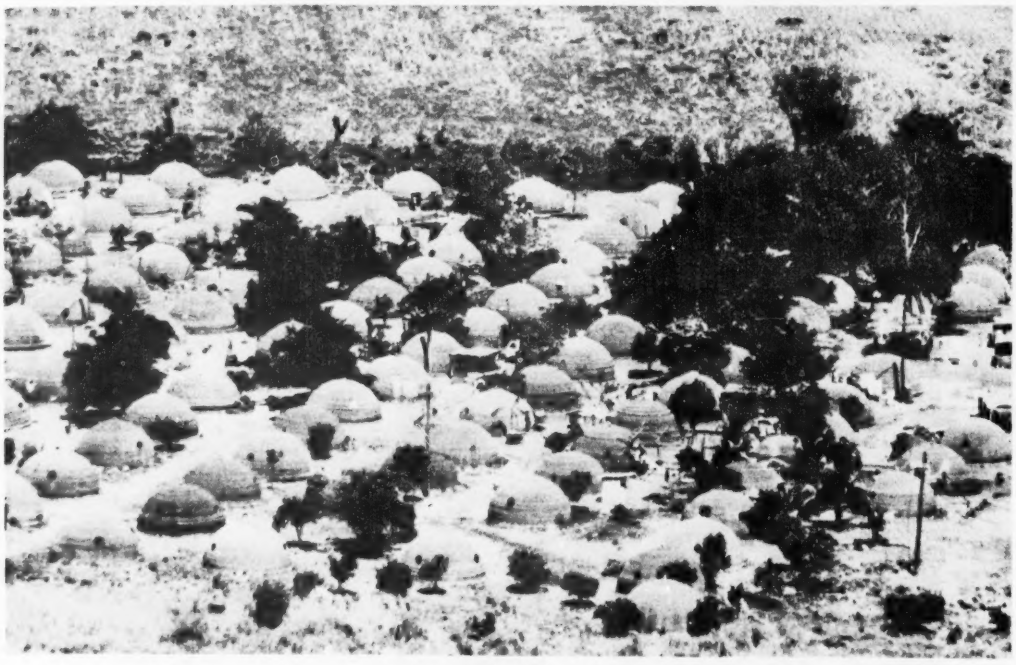

Figure 2. Bayer/W. German Red Cross Polyurethane Igloos, Masaya, Nicaragua, March 1974.

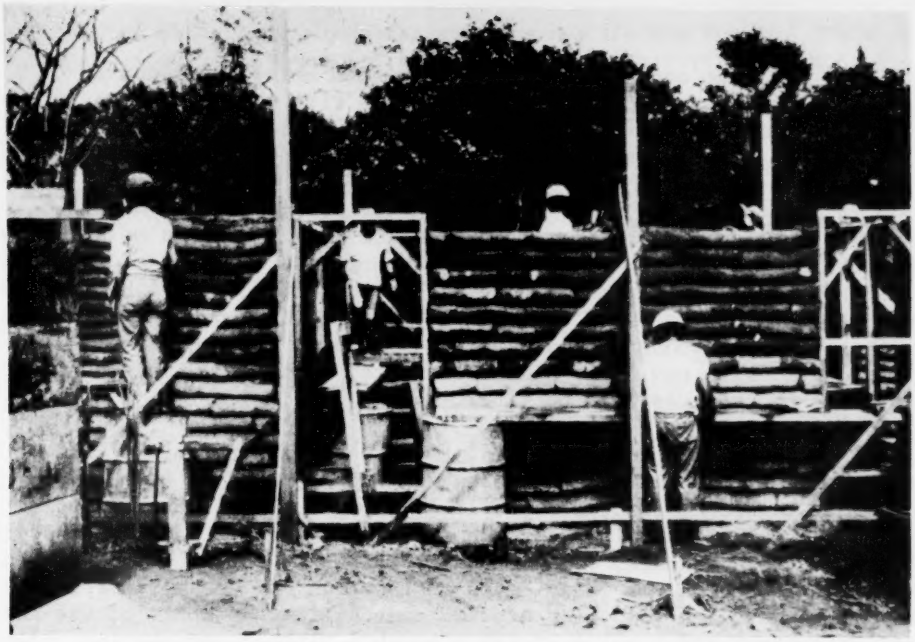

Figure 3. Masatepe, Nicaragua. Stack-sack permanent housing. Sacks of cement and sand are dipped in water, then spiked over vertical short steel bars, thus forming a simple type of "reinforced concrete" wall, resistant to earthquakes.

Advanced techniques using local materials. Other examples of western designs have used advanced technology with existing local housing traditions. Notable examples include:

(1) The Carnegie-Mellon prototype housing using triangulated bamboo "A" frames with thatch covering.

(2) The C.A.R.E. 'Cinva-ram' housing system has been used in many contexts, including Bangladesh where consolidated earth (a mixture of cement and soil very firmly compacted to form bricks) is used for the walls of houses. A project for 100 of these homes was financed by Oxfam.

(3) Stack-sack housing in Peru and Managua, using a technique of sand bags filled with cement and sand, erected like brickwork with small reinforcing bars spiked into the bonded sacks as they are erected (See Figure 3).

(4) Tilt-up concrete housing. A system being developed in Choloma, Honduras after hurricane Fifi where concrete walls of units are poured on the ground to save formwork costs, then tilted upright by a metal erector.

Indigenous techniques. Finally in the realm of donor housing, there is the type of solution that uses local skills (with no significant modification) and local materials. Numerous examples of this could be found, for example the rural housing produced in Bangladesh by EFICOR and now the NEED consortium. About 1,300 homes were built using a frame of wooden posts with partitions of woven jute, sometimes coated with cow dung, and a corrugated iron roof. The total cost of each unit was $123.00 (£52).

Tents. For hundreds of years, tents have been the basic form of emergency shelter. After the Lisbon earthquake of 1750, Antonio Pereira de Figueiredo described peoples' reaction: "The general desire was to get out of buildings into tents or huts, and to sleep in the garden rather than indoors, even if one's home still stood safe and sound, and for this reason the great camps on the high and open places round the city were for a long time crowded communities, in spite of the initial discomfort and squalor of the miserable bivouacs of matting, plants, and sail-cloth under which many of the squatters spent their first nights."

Tents also constitute one of the few types of mass shelter that are stockpiled. A.I.D. keeps stockpiles, containing up to 10,000 frame tents, in various key places throughout the world--Europe, Asia and Latin America. The Red Crescent in Turkey and Iran also stockpile bulk supplies of up to 20,000 ready for use which are manufactured by refugees of one disaster, ready for the next.

Two significant problems with canvas tents are their rapidly rising cost, and their weight in transit. It is hoped that the plastic, woven polythene tents, being developed specifically for disaster situations by a Japanese firm, will be both lighter and cheaper. These were developed to a specification worked out by Jurg Vittani of the League of Red Cross Societies, and so far have been used in flood situations in the Philippines, as well as Vietnam, Laos and Cambodia. However, reports have yet to be provided on their performance.

The only attempt, to my knowledge, of town planners applying their particular skills to tent location was the layout Fred Cuny worked out for El Coyotepe camp in Nicaragua. This produced a humane environment in sharp contrast to the usual regimented military camps; it was based on the use of family clusters, localized cooking and sanitation units.

Another obvious problem with tents is climate; most designs are not resistant for long periods to extreme heat or cold, or to high winds. Finally, there is the problem of the homeless bringing their scraps of

furniture with them, which can easily puncture the fabric. This is a major reason why agencies like Oxfam use only heavy-duty tents.

Advantages unique to tents are the fact that they can be erected within hours, and their relative lightness and compactness for bulk transit. Various proposals have been made for the use of inflatable structures, or even large marquee tents which can then be subdivided internally into small cubicles for individual families. Although there are cost reductions in such proposals, there remains the apparent dislike of families for multi-family dwelling units.

Research activity. One of the most encouraging activities to emerge in recent years is a concentrated research effort to establish criteria for emergency shelter. Unfortunately, much research work has been non-productive in that a misdirected emphasis has been placed on designing a single disaster shelter to solve the whole world's shelter problems--an impossible aim given the wide range of cultural and climatic variables. Much worthwhile research activity in the housing and disaster sphere has been in the area of pre-disaster planning: to devise building codes, better siting of houses and simple, realistic ways to prevent buildings collapsing.

Local Responses

In addition to the "external" contributions discussed so far, there are a number of "internal" responses to disaster situations, which may operate simultaneously and result from both official decisions and the *ad hoc* decisions of individual families.

Extended families. One major *ad hoc* response is reliance on the extended family. About 250,000 people were homeless in the Managua (Nicaragua) earthquake, but it would appear that 90 percent were absorbed by families and friends. A census taken four weeks after the earthquake in four outlying towns, swollen with refugees, indicated that no less than 130,000 in these towns alone had been absorbed by extended families. Seven weeks after the earthquake a further census revealed that 80,000 were still in these adopted homes. However, we cannot deduce from this that a similar response will always take place. For example, the extended family "sponge" cannot function in long-term disaster situations such as the Sahel drought, for the obvious reason that everyone is affected. Another context where it won't function is in the refugee camps of Bangladesh or Bengal, where people have been uprooted from their environment. Even in rural situations like Lice, Turkey where villages are more self-sufficient with little outside contact, initial studies confirm this response is unlikely to take place.

However, in urban areas, particularly where urbanization has been rapid (as in most cities in the developing world) there will exist strong rural links for most, if not all families, and this is of great benefit after a disaster.

Self help. Another common response is for the families to rebuild their own housing. The ability of most families in the developing world to build their own houses is often overlooked, since we have been getting away from that basic skill in the western world. So in assessing the priority of shelter, it should be noted that a very large percentage of post-disaster reconstruction will be taking place irrespective of donor provision or public regulations (Figure 4).

In the post-war situation in Bangladesh, out of a total housing need of 1.5 million units, the relief agencies built a total of 450,307 units between January 1972 and June 1973, while one million

Figure 4. Patzicia, Guatemala, six days after the earthquake of February 4, 1976. House owners rebuilding their homes.

were probably rebuilt by owner/builders in the same period without special assistance. It is often argued that disaster victims are in such a state of shock after a disaster that they cannot fend for themselves. Perhaps this is true where there is extreme malnutrition, or in the dehumanizing conditions of the refugee camp; but there is evidence that people show high levels of initiative in most disaster situations.

Underuse of shelters. The unwillingness of refugee families to occupy donor housing is another frequently overlooked response. In the town of Masaya, outside Managua, igloos provided by the West German Red Cross (see Figure 2) were rent-free housing. Despite this, only 75 out of 310 units were occupied. An analysis of provision in other situations tends to confirm the fact that low occupancy is more likely to be the norm than the exception. The A.I.D. wooden houses in Managua were only 35 percent occupied eleven months after the disaster. In Chimbote the multiple family units built by the Peruvian government and A.I.D. were again little used, as were the United Nations shelter units. In Skopje seven months after the earthquake only 179 families were living in the Nissen huts and quonset huts provided by the British and Americans; the capacity of these units was at least four times that total.

Reasons for this underuse may include: overestimates of the homeless population, excessive volumes of aid; the mislocation of the units --often away from bus routes, a vital requirement as work gets back to normal; cultural rejection of unusual forms of housing (see Figure 5); the almost universal hostility to multi-family units; and finally, the fact that as more permanent housing becomes available it is seen as a better alternative. From the use of extended families, the desire of people to rebuild their own homes and the underuse of so many forms of shelter supplied from the outside, it seems there is a strong tendency to exaggerate the priority or importance of shelter provision, and relief agencies may have been wise to give it low priority.

The Official Response

One obvious need in any permanent building work in a disaster-prone area is to advocate that all public buildings, schools, hospitals, churches, and police stations are built to such standards that they will not collapse in any disaster. Thus, they can be brought into immediate use as morgues, dispensaries, food distribution centers or emergency shelters. In the Managua earthquake schools and churches collapsed, and it seems that new schools have been rebuilt in a very vulnerable form. If this is the case, it is a very short-sighted policy. However, for obvious reasons the time span of this emergency use is limited, as normality returns and the buildings are required for their original purpose.

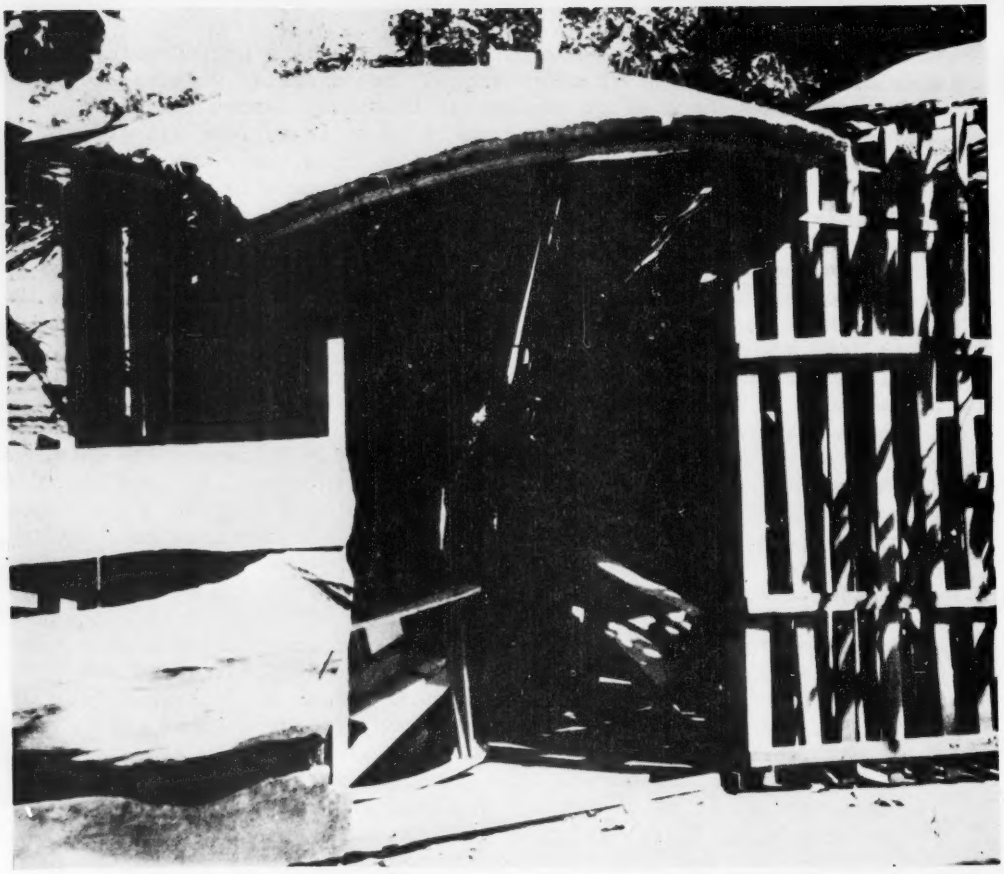

Figure 5. Bayer/W. German Red Cross polyurethane igloos, an example of the "improvisation process"--note the way a less acceptable "round" igloo has been converted into a "rectangular" house.

One role that outside consultants can play is to detect the intrinsic weaknesses of the local permanent forms of architecture relative to their vulnerability to disasters. Although traditional forms respond to cultural, economic and climatic factors, they rarely respond to disaster hazards--with the possible exception of the Japanese lightweight timber house.

Sometimes the official response is to evacuate the area. In numerous disaster situations governments, worried about health risks

or food availability, have attempted to evacuate all inhabitants except the men needed to clear rubble and assist in relief work. However, they may not stay away. In Skopje, for example, 150,000 left for home within the first three weeks. Families did not like being split up, children could not speak the language of different Yugoslav republics, and the net result was that within 2½ months they had virtually all returned. It is worth noting that the twin desires, to return to one's home and to remain with one's family, are so powerful that people will tolerate almost any degree of discomfort to achieve them. These attitudes are very important when various strategies are considered.

Lessons From Experience

Cost Factors. In the data from the seven disaster case studies covered here, the number of variables makes a simple comparison of cost figures almost meaningless. However, certain patterns emerge.

(a) *The cost of temporary donor provisions using western technology may be higher than that of permanent housing.* In Gediz, precise costs of permanent housing are not available, but it is highly probable that the temporary igloos costing about $31 per square meter were more expensive than the new permanent pre-fabricated units. In Lice, although five years had passed since Gediz, a similar situation emerges. Again precise costs of the new pre-fabricated houses have yet to be ascertained, but the approximate cost of a house, including sanitation and services but without costs for infrastructure is $31.70 per square meter, compared with $31 per square meter for the Oxfam polyurethane units. If the transportation costs are added and averaged according to the number produced then the total cost of these temporary plastic units rises to $40.70 per square meter.

The conclusion is that in terms of value for money the high technology donor solutions (German igloos and the Oxfam hexagonal units) are comparable in price to fully serviced permanent housing. If development costs for the igloos are added, the donor situation would be seen in an even more unfavorable light. Reasons for the high cost include expensive imported materials, high western labor costs in comparison with labor rates in the developing world, and high transport costs. In simple terms this implies that in Lice 71.8 pre-fabricated, fully serviced houses costing $2,000 each could probably have been purchased for the same price as 453 temporary structures.

(b) *The cost of donor shelters becomes comparable with local provision when indigenous materials and techniques are adopted.* The Carnegie-Mellon University "A" frame units cost about $4.37 per square meter, while the EFICOR rural housing in Bangladesh (units built using a frame of wooden posts with partitions of woven jute, sometimes coated with cow dung, and roofed with corrugated iron) costs about $10.00 per

square meter. There are no local statistics to compare with these figures, but obviously when local skills and local materials are used the price is similar to local provision, even though finance may come from an outside donor.

In both of these examples the actual cost of the units was determined in advance of the design to make certain that the shelters were economically viable for the occupants. This is obviously vital; but it is quite impossible in the case of donor shelters relying on western products which cannot be modified to suit prevailing market conditions.

(c) *The obvious cost saving of multiple units emerge from these figures.* The "Basha" multiple housing units, used in the Bengal refugee crisis in 1971-72 cost about $1.12 per square meter; and with the semi-detached "A" frame units by Carnegie-Mellon, the idea of dual units has helped to keep the cost down to $4.37 per square meter. It is surprising that the obvious cost savings from units accessible from each side have not been exploited more frequently.

Timing Factors. (a) *Emergency shelter.* The overriding impression from an examination of donor provision is the extensive time it takes to arrive and be installed. In the seven case studies, the first occupants rarely moved into donor housing in under 60 days, and in some cases the figure is nearer a hundred days. Reasons for the delay include the time for setting up projects (with evaluation missions reporting back to the home base), transport difficulties, government red tape and land tenure issues. In contrast, figures for tent usage show they are normally occupied the night after the disaster and most camp sites are established within the first week.

(b) *Permanent housing.* The figures for the occupancy of permanent housing are relevant in the cases of Skopje, Managua and Lice. In Skopje, 210 days after the earthquake, 14,000 houses were completed. In Managua permanent houses were being completed within 40 days of the earthquake, while in Lice 1,500 homes were completed by day 56. The conclusion is that it is possible, given the governmental will and rapid land acquisition, to build permanent shelter very rapidly.

Conclusions

On the basis of the evidence discussed so far, it is possible to set down certain key criteria for emergency shelter. Provision should aim to:

(1) utilize local resources, which will be readily available;
(2) avoid the imposition of novel solutions, that may well be rejected along with unfamiliar foods;

(3) encourage a labor-intensive solution, thus providing much needed work (possibly of high therapeutic value after a disaster);

(4) recognize the need for shelter provision in different areas to vary according to local cultural patterns, local materials and local climate;

(5) recognize that it is better to sell or rent than to give, even if the rent is minimal. This helps to preserve the dignity of the occupants, and I suspect that when shelter is offered free of charge it may lead to low occupancy. However, the people needing shelter may be among the poorest of the population; for the housing to be viable in their terms it must be very cheap. Housing for the poor must never cost more than twice the occupant's family annual income,

(6) recognize that emergency shelter must be rapidly available. An American study, undertaken for the National Academy of Sciences,indicates that emergency shelter is required within the initial 48 hours and temporary housing in the first ten days. However, only in the case of the Gediz was "donor housing" occupied in under 60 days. If shelter cannot be provided within three days, or one week as the absolute limit, then it has little validity, since from this time onwards the emphasis must be towards permanent housing recovery.

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Living with Earthquakes

D. J. Blundell

[Earthquakes--where and with what frequency do they occur? What seismological changes lead to them? What advances are being made in their accurate prediction? What measures might be taken to mitigate their impact? These questions and more are addressed in the following article.]

Earthquakes--Where, and How Often?

With the memories of recent earthquakes in China, Indonesia, Italy, Guatemala and Turkey, it is timely to reconsider just how much longer we must accept such tragedies. An earthquake is a natural occurrence, but does the disaster that follows also have to be regarded as an "act of God"? Disasters are man-made where they relate to losses in human lives and property--if we could avoid living near earthquakes then no such disasters would arise.

Earthquakes occur mainly along well defined zones around the earth that are long and relatively narrow belts. The majority of earthquakes occur in a belt peripheral to the Pacific Ocean on the west coast of North and South America, or in Japan and the Philippines; and along another from Indonesia through northern India and Iran to the Mediterranean; major earthquakes also occur regularly across a wide region of China and eastern USSR, while occasionally causing damage in places well removed from the main seismic zones. Earthquakes are monitored on a global basis by a world-wide network of seismological observatories which record the arrival of seismic waves (vibrations

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from inside the earth) generated by the earthquakes that have travelled through the earth. The *focus* of each earthquake--the point inside the earth from which the seismic waves emanate--and the *epicenter*--the point on the earth's surface directly above the focus--can be located from an analysis of the seismic records. A measure of the magnitude of the shock is given from the amplitudes of the seismic waves that are recorded. A logarithmic (to base 10) scale of magnitude is used, called the Richter scale, in which earthquakes of magnitude 6 or greater are all potentially dangerous. Thousands of minor earthquakes occur each year around the world. Hundreds of these are strong enough to cause a noticeable shaking of the ground, and perhaps twenty or so are great enough to cause major damage. Fortunately, most of these occur in regions remote from habitation, but with the ever increasing spread of population around the globe the risks of further disasters must be increasing.

At present there seems to be no way of preventing earthquakes from occurring; and if it is accepted that they occur over sufficiently wide and valuable areas of the world that we have to live with them, the question is then to know how best to mitigate their hazardous effects. In a zone of earthquake risk one has to be prepared to counter this hazard, but unfortunately it is but one of life's hazards and may by no means be the most pressing. After all, the loss of life from earthquakes is small compared with road accidents, preventable diseases, wars and other man-made hazards. Even in a highly active region, damaging earthquakes may only recur at intervals of 30-50 years, so it is not surprising if governments find other priorities taking precedence over earthquake hazards. Consequently, to judge their priority, one needs to assess the risk from earthquakes; some means of forecasting their future occurrence seems imperative.

Forerunner Effects

The past few years have seen a considerable advance in finding signs to indicate an impending earthquake. Unfortunately, public expectations of a forecasting service are rising faster than research progress, and scientists are becoming increasingly wary of committing themselves. Perhaps the most striking advance has come with the discovery by Russian seismologists, later confirmed in the United States, Japan, and elsewhere, that on some occasions, changes in the ratio of the velocities of propagation of longitudinal *(P)* and transverse *(S)* seismic waves occur in the vicinity of the focus of an impending earthquake. (This refers to shifts in the speeds of movements of earth vibrations running at right angles to each other as measured on the earth's surface.) It seems that the 10 percent or so drop in the ratio *Vp/Vs* observed ahead of an earthquake is due to changes in the mechanical behavior of the ground when it is under pressure and stressed near to the breaking point. Evidence suggests that this has to do with the

flaws or cracks in the rock; the effect is called *dilatancy*. There is also evidence to suggest that the larger the magnitude of the earthquake, the larger the volume of rock actually involved in the earthquake source region. This has been used to explain the observation that the time period for which *Vp/Vs* decreases ahead of an earthquake is related to its magnitude: the longer the time delay, the larger the earthquake. It is this observation that has given rise to the hope that the phenomenon may be sufficiently prognostic to predict not only the place but also the time and magnitude of an impending earthquake. But the observations of the *Vp/Vs* changes have only been discovered, in most cases, after the event. Only one or two claims have yet been made of using it successfully to predict in advance. To put it into practice, a network of sensitive seismometers must be located within a few tens of kilometers of the earthquake, and even then the magnitude of the changes sought is only slightly greater than the accuracy of reading the records. Despite its early promise, seismologists have become somewhat discouraged by the unreliability of the method, at least in its present state of development.

Even so, the discovery of these changes in the seismic properties of the ground suggest there may be other measurements which could be made of the same physical phenomenon that might be equally or perhaps more characteristic. It gives new impetus to measurements of the deformation (i.e., changes in shape) of the ground surface, which has been monitored for some years in earthquake risk areas. Particularly across geological faults, lines have been surveyed repeatedly to observe any small vertical or horizontal movements of the ground surface. Here the problem has been to distinguish between deformation that is an elastic response of the ground to increasing stress, one which will eventually result in an earthquake when the fracture strength of the ground is exceeded, and deformation that is a plastic response which results in creep movements rather than earthquakes. Careful geodetic measurements, such as repeated surveys, the use of tiltmeters and measurements of small changes in gravity, carried out over a region where an earthquake is expected, do look to have the potential to pick out the dilatancy effect (causing the *Vp/Vs* anomaly) and they may prove more reliable as predictors. Other related observations include changes in geomagnetic field, and the electrical conducting properties of the ground. Such is the present state of the art that, in prediction, the best hope seems to lie in the comprehensive use of all these criteria together rather than relying predominantly on any one. A major effort is needed for any chance of success, so that only when the risks of disaster are high can it be sustained. Several countries are indeed making this effort, but the only successes claimed so far have come from China (see below).

Figure 1. Scene of devastation at Lice. A general view showing the devastation at Lice in Turkey after an earthquake totally destroyed the town killing more than 2,200 people and with more being dug from the rubble by rescue workers. Army roadblocks were turning back all but essential and military vehicles on the outskirts of Lice, where there was still little to eat or drink. (Associated Press Photo from London.)

Assessment of the Earthquake Hazard of Different Areas

The first step in the assessment of area hazard is to get data on past and current earthquake activity. Seismic observatory records give information only for the present century, and in detail only for the last two decades. This time span is too short to describe adequately the pattern of seismic activity as a basis for prediction, so historical descriptive records of earlier earthquakes are an important contribution to our knowledge. In a few places where these have been studied, important information has come to light concerning the variations in

space and time of past earthquake activity. There is no doubt that earthquakes are closely associated with patterns of geological faulting, and it is also clear that earthquake activity can migrate along fault zones, so that at any one location there may be periods of intense activity of perhaps 50-100 years duration with intervening periods of relative quiescence lasting 150-200 years. So, following these patterns of migration, where they can be recognized, can help to pinpoint areas where earthquake activity can be expected next. These are sometimes areas where recent activity is slight and represent "seismic gaps," possibly soon to be filled.

When relying on historical records, the size of an earthquake has to be judged by the surface effects, largely based on the damage to man-made structures that it causes, rather than on exact measurements. A scale of earthquake intensity has been devised which is a macroseismic measure of the effects of ground motion upon buildings and other structures. Since its estimation depends first of all on the presence of such structures and the ensuant damage depends on their design, construction and foundations, the scale is perforce semi-descriptive and subjective. Nevertheless it is a scale with practical value since it relates directly to the damaging effect of an earthquake, and it provides some continuity between historical records and modern instrumental recordings (which use the Richter scale). The modified Mercalli scale in common use ranges from an earthquake of intensity I which can only be detected with instruments, through V which is sizeable enough to rattle objects on shelves and cause public disquiet, to intensity XII which produces complete devastation. Historical and recent observatory information on the location, frequency of occurrence and size of earthquakes can be put together with geological and geophysical information locating active fault structures to compile seismotectonic zoning maps that provide predictive information on the probability of the extent of earthquake activity at each location. Information of this kind, however, is sparse and only a few countries, notably Japan, USSR and USA, have reasonable coverage with such maps. Other countries, particularly around the Mediterranean and in Central and South America, are making good headway in preparing this baseline information.

Earthquake Prediction in China

In the light of this kind of knowledge it then becomes possible to highlight those areas that appear to be in special danger, and to monitor these sufficiently closely for prediction to be feasible. Study of migration patterns and of the past history of earthquake activity led Chinese seismologists to suspect in 1970 that the province of Liaoning about 500 km east of Peking warranted special attention. The seismological observatory network there was strengthened, and a program of repeated leveling, surveying and other geophysical observations was put in hand. As seismic activity in the area increased and re-levelling showed ground deformation to be accelerating, the scientists became con-

vinced by early 1974 that things were building up towards a major earthquake. The pattern of epicenters was related to a NE-SW trending fault zone, and the re-leveling indicated ground rising in the SE and subsiding in the NW with the strongest gradient of deformation near to the fault zone. The activity was also centered in a NW-SE direction about a cross fault so the likely epicentral region could be predicted. Seismic activity in 1974 had increased to five times above normal for earthquakes of magnitude less than 5 on the Richter scale. By June 1974 the combined information led to the prediction that an earthquake of magnitude between 5 and 6.5 would occur within 1-2 years near Haicheng.

Based on this, the help of the general public in the locality was enlisted, both to form teams of amateur observers to strengthen and enlarge the range of monitoring observations, and also to make practical preparations to reduce the hazards from the expected earthquake. The seismic and geodetic measurements were thus augmented with local observations of geomagnetic field, natural earth currents, the monitoring of water levels in wells and of animal behavior. At the same time, people were instructed how to act best for self preservation when the earthquake occurred; buildings were inspected, some strengthened, some designated to be evacuated; light temporary buildings were prepared, and relief services generally organized. In the ensuing months a variety of effects were noticed by the amateur observers. Water wells changed level in unusual ways, with the majority showing rises in level, a few even becoming artesian. A third became muddy and bubbling. The pattern of activity also pinpointed the likely epicentral region. Various animals, both domestic and wild, displayed abnormal behavior. Only a few individuals within any one species ever behaved oddly, but reports covering 10 different species began to add up. Mice and snakes seemed to be the most sensitive, with snakes appearing from their holes out on the ice and snow in the depth of winter, something normally unheard of. The pattern of locations where such abnormal behavior was reported was initially widespread, but it began to converge on the expected epicentral region.

Early in 1975 an earthquake of magnitude 4.8 about 80 km north of Haicheng caused some public alarm, and must surely have occasioned some doubts and misgivings among those concerned with the prediction of a major earthquake. Then, early on February 4, 1975, the seismic network recorded a swarm of earthquakes with unusual characteristics and closely grouped within the expected epicentral region. This was correctly interpreted as a foreshock sequence, which is known sometimes to precede a major shock. By midday the local authorities had been alerted and the general public were set in a state of preparedness, moving elderly and infirm to places of safety, livestock out of their barns into the fields, and congregating in open spaces. The main earthquake occurred at 7.36 p.m. that evening and was of magnitude 7.3. Because most people were in the open, casualties were very slight, even though damage to buildings was severe. In one village of 3,000 population no-one was

killed, even though 82 dwellings out of some 800 collapsed completely and many others were severely damaged. In another, one child died, from a population of about 3,500, where 90 percent of the houses were destroyed. The Chinese ascribe this success in preventing disaster as much to the education and mobilization of the public at large as to the monitoring program. They claim to have successfully predicted and taken effective preventive measures for 10 earthquakes, of which Haicheng has been the most spectacular. However, success was very dependent upon the observation of the foreshock sequence, and it is clear that estimating the exact time and magnitude of an earthquake remains a chancy undertaking. With hopes raised by this success it is doubly tragic that China should suffer such calamitous losses on 27 July, 1976, near Tientsin.

Pitfalls of Prediction and Pronouncement

The unreliability of predicting the time and magnitude of an expected earthquake is well illustrated by Japanese experience. Careful observations have led to the pinpointing of several areas where a severe earthquake must be expected. In the Boso Peninsula south-east of Tokyo Bay, geodetic measurements indicate substantial ground deformation around a fault zone that has been building up since a great earthquake occurred there in 1923, but so far there has been no increase in seismic activity to suggest that another earthquake is immediately imminent. There is also evidence of the build-up of ground deformation in the region of Tokai, which has a history of great earthquakes of magnitude 8 or more recurring in 1498, 1605, 1707 and 1858. Just offshore to the south a "seismicity gap" has been recognized. But so far no other precursory phenomena have been diagnosed. More urgent signs of an impending earthquake are found at Kawasaki, an industrial town situated at the mouth of Tamagawa River, south of Tokyo. Here, releveling measurements have shown ground elevations to be rising at accelerating rates that are exceeding 10 mm/yr, as compared with 5 mm/yr observed in Haicheng. Some of the uplift can be ascribed to recovery following subsidence caused by excessive pumping of groundwater near the river, which has recently been strictly regulated and reduced. Observations of water levels in wells have shown marked rises, that could be due to the restraint in pumping. However, the anomalous uplift of the ground covers a wider area than where subsidence had previously occurred, and radio-carbon dating of well water has shown that not all of it could have been recently replenished so that the uplift must have a more deepseated source.

Kawasaki has a past history of damaging earthquakes. Some of the signs used by the Chinese to predict the Haicheng earthquake are present. The Japanese have a well-organized program of earthquake prediction research and are intensively monitoring the area. The general public are well aware of earthquake hazards and know what to do when

one comes. But with uncertainty in estimating the time and size of a future earthquake, it is difficult to set a balance between maintaining a state of alert and preparedness while avoiding false alarms that can detract from the credibility of the forecast service.

This problem is equally pressing in California, where the dangers inherent in unreliable forecasting are well appreciated. Research into the social and economic consequences of earthquake forecasting is being carried out in parallel with research into forecasting itself. The hope is that research progress can be sufficiently rapid to minimize the period of unreliability; if not, the social consequences of forecasting could be more damaging than useful. It is not thought in California that they yet have the basis for a forecasting service. Scientists have already resolved that when predictive information does become available, the general public will be told straight away, but any forecast will be qualified with a statement about its reliability.

Mitigating the Earthquake Hazards

Forecasting an earthquake in time, without false alarms, can allow preventive measures to be taken, alert the public to the danger, and ensure that services are maintained. Hospitals must continue to function in the aftermath of an earthquake. Fire brigades must also function effectively to reduce the serious fire hazard that exists in any urban area. These and other public services and utilities can best be maintained if they are given advance warning. The Chinese example has shown how greatly the casualties can be reduced compared, say, with Managua, Nicaragua where 1 percent of the population were killed in the 5.7 magnitude earthquake of December 1972. Yet forecasts have their limitations since they relate to prognostications only a year, or months, or even hours ahead of the event--too late to do anything about bad design or bad construction or bad siting of the structures in which the people who are killed get buried. Most of the losses, both economic and human, are preventable only if buildings are built to be earthquake resistant.

It would be too much to expect to build structures so that they should all survive undamaged in the strongest earthquake ever known. The cost of strengthening to this extent would be prohibitive, and unnecessary in terms of the other risks we face in living on earth. But it is feasible for engineers and planners to devise design criteria ranging in complexity according to the requirements of each structure, dependent on the risks involved. Large dams and nuclear power stations, for example, need stringent criteria because of the inherent dangers of secondary hazards should they collapse. Single storey houses, on the other hand, need simple criteria. It is found that heavy roofs to provide good insulation which are not well enough supported cause many deaths, so persuading people to change their traditional methods or

materials for house building can be a simple remedy in preventing tragedy where such changes are practical and affordable. Often where designs are adequate, buildings collapse in an earthquake through bad construction, so that human failings become responsible for disaster. Engineers are able to work on the basis of seismic zoning maps, where they exist, and sites of large structures can be monitored before and after construction. But there are still major gaps in our knowledge. For example, very little is known about the pattern of ground movement in the epicentral region close to the source of an earthquake. As it is here that the worst damage usually occurs, and as the observed damage seems to vary greatly in extent even within a few tens of meters, it is difficult as yet to translate the seismic magnitude data of earthquakes observed from a distance into the criteria engineers need for designing structures which may one day find themselves at the epicenter.

In terms of human suffering, much of the damage caused by earthquakes is preventable, not so much through prediction, but mainly through the adherence to codes of practice in the location, design and construction of buildings and other works. Countries advanced in earthquake disaster prevention have such codes. In others, codes have little practical meaning if they exist at all, and life goes on fatalistically in the knowledge that one day an earthquake may happen--but then it may not; it happens so rarely within the human lifespan. So memories of past misfortunes fade, more immediate problems take precedence, and the whole thing becomes someone else's problem. But if earthquakes take fewer lives than motor cars, their effect is more disruptive. It takes just one earthquake to devastate a whole city and put the economy of a region or a country to ruin. It is the small, developing country that is most vulnerable.

Unfortunately, the most vulnerable also appear to be the least aware or, at any rate, the least active or capable in attempting to mitigate the hazards. Somehow, each country concerned must seek to assess its own earthquake risk along with the other hazards which waylay the fulfillment of its development plans. Earthquake risk is the compound of two factors: the seismicity of the region, and the vulnerability of the society to earthquake hazard. The former is largely a matter for assessment by earth scientists, while the latter is the domain of engineers, economists, politicians and planners. What is required now is for all these to work together.

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Methods for Speeding Food Relief in Disasters

Mitchel B. Wallerstein

[Minimizing the delivery time for food supplies following a disaster is a goal of many emergency assistance agencies. Use of satellite tracking systems for finding and diverting nearby ships carrying grain, computerized locator systems for these ships, and regional grain reserves are three possible approaches. The pros and cons of these methods are discussed.]

Despite recent initiatives to improve the effectiveness with which international disaster relief efforts are coordinated, most actions taken in the immediate wake of an emergency have remained largely *ad hoc* in nature. Donor countries and non-governmental organizations contribute whatever they have available at the time or can obtain at short notice. The specific concern in the present context is with the matter of food-related needs in disaster situations and whether modern technology can, in the future, play a role in speeding the delivery of appropriate commodities to the affected area.

The present study goes one step further by investigating the actual feasibility of alternative technological systems that might speed food disaster situations. The application of "technological fixes" has long held great attraction for policymakers because they offer the possibility of solutions that can be implemented relatively quickly. It is increasingly apparent, however, that such technological approaches will continue to be appropriate only as a most basic form of first aid, and that sophisticated

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technology cannot and will not obviate the need for preparedness planning or adequate attention to economic and social development. Moreover, in most crisis situations, the immediate food needs of a population can be met relatively quickly, at which point the remaining need would not be for additional foodstuffs but for other types of reconstruction assistance.

There are, in any case, at least three alternative technological approaches to the problem of the efficient channelling of food commodities to disaster zones. The first would employ the remote sensing and communications capabilities of satellites to track the actual position of grain-carrying ships at sea. With the second alternative, approximate ship positions would be plotted based on regularly updated information on course, speed, and intended destination; a number of computer software programs of this sort are already in existence. The third approach rejects the idea of diverting ships at sea and proposes instead that modest food reserves should be held in regional storage facilities in "high risk" areas and then moved directly to the disaster zone when needed.

Scope of the Problem

Before considering the question of how (or whether) to trace grain ships at sea for possible diversion in emergency situations, let us first set the matter in the context of the larger global flow of food commodities. In 1976 international trade in food grains totalled more than 77 million metric tons, almost all of which was directed to the developing world. But the actual shortfall in disaster situations for any given year is normally rather modest when compared to these volumes, and because of the extreme difficult and complexity of diverting commercial food shipments, this study will be confined only to the question of diverting flows of food grain moving as aid.

The preceding statement is meant to apply to the so-called "fast" developing emergencies such as earthquakes, floods or civil strife, and not to the so-called "creeping" emergencies such as droughts or famines which obviously require a far greater volume of food supplies over a longer term. Because of the secretive and competitive nature of international grain trade, the movement of commodities is very closely-held information. Moreover, because the U.S. grain companies rarely own the grain once it has been shipped, diverting the cargo would be much more costly and time-consuming than in the case of food aid which is owned by a government or international voluntary agency.

Finally, it may be useful to provide some sense of the size and distribution of the world merchant marine fleet and the volume of grain movements within this context. Grain is normally transported in so-

called ore/bulk carriers which, in 1970, comprised less than five percent of the world shipping fleet. Due to their size, however, ore bulk carriers transport annually about 25 percent of the world's commodity trade. Grain may also be carried in converted oil tankers (when suitably cleaned and prepared), and together with the bulk carriers, this represents over 75 percent of the total carrying capacity of the world's merchant fleet.

By 1980, nearly 90 million metric tons of grain was being transported annually by ship with an average voyage length of about 5,000 miles. Table 1 provides a summary of the number of tankers and ore/bulk carriers estimated to have been to be at sea in 1980, while Table 2 indicates the number of vessels likely to be operating in each major ocean. While not all of these ships would always be carrying food grains, it nevertheless becomes apparent from this data that, unless it is possible to differentiate cargos of commercial food *trade* from cargos fo food *aid*, the number of vessels that any system would have to identify and keep track of on a daily basis will be extremely large.

Model One: Satellite Tracking Systems

The most technologically sophisticated and capital-intensive method for keeping track of the global movements of food would employ earth orbiting satellites to continuously track and communicate with

TABLE 1

ESTIMATED NUMBER OF TANKERS AND ORE/BULK CARRIERS AT SEA IN 1980 (TOTAL NUMBER OF VESSELS SHOWN IN PARENTHESIS)

Size (Gross tons)	Tankers	Ore/Bulk carriers
100+	5,559 (7,039)	3,519 (5,370)
1,000+	4,455 (5,426)	3,519 (5,370)
6,000+	3,990 (4,748)	3,519 (5,370)
10,000+	3,850 (4,533)	3,235 (4,900)

Source: Adapted from: Charles Dorian, Applications of space communications to the Maritime Mobile Service, *Telecommunication Journal* 33, 344, Table 1 (May 1971).

ships, and a central computer storage and retrieval system to update this information on a daily--or, perhaps, even hourly--basis. The scheme proposed most frequently is modelled after the one employed currently by some of the large multi-national oil companies for monitoring the movements of their tanker fleets.

TABLE 2

ESTIMATED NUMBER OF VESSELS AT SEA IN MAJOR OCEANS IN 1980

Ocean	Tankers	Ore/Bulk Carriers	Total
Atlantic	4,342	2,474	6,816
Pacific	2.229	3,930	6,159
Indian	2,529	322	2,851

Source: Adapted from: Charles Dorian, Application of space communications to the Maritime Mobile Service, Telecommunications Journal 33, 344, Table 2 (May 1971).

Each oil company operates its own transportation management system which commonly includes computerized recordkeeping on tanker departures, cargo, intended destination and routing. Vessel masters maintain contact with the home office via the MARISAT communications satellite, or through advanced ship-to-shore radio, and they usually notify the company of any en route delays exceeding 6-12 hours. Ships must also report their position at certain pre-determined geographical check points. Due to the competitive nature of the oil business, companies do not as a rule share information voluntarily on specific ship locations. However, as a result of the serious distribution problems which occurred during the 1973 Arab oil embargo, a standby emergency reporting system was created--at U.S. initiative--as part of the International Energy Agency (IEA) located in Paris.

The obvious advantages of the MARISAT system in the context of disaster relief is that it facilitates easy position tracking and rapid communication with ships anywhere at sea. It has a number of disadvantages, however. For one thing, the cost of the basic equipment and user fees are high in comparison to other available alternatives. Second, unlike the oil industry, where a large portion of the fleet is owned by the companies themselves, many different types of ships (e.g., bulk carriers, idle oil tankers, etc.) carry grain, and most operate on a charter basis. Third, many grain vessels are old and dilapidated; it is somewhat unlikely, therefore, that the owners of such vessels would be willing to invest additional capital simply in order to make use of the MARISAT system. Finally, many grain transport vessels do

not carry grain exclusively, and there would be little incentive for vessel owners to agree to participate in an international system unless offered powerful incentives to do so (e.g., cost-sharing for the communications equipment or preferential treatment in the awarding of charter contracts).

Model Two: Computerized Locator Systems

A second possible method of tracking the movement of food grain shipments eliminates the satellite link entirely and reduces greatly the participation burden on shipmasters and the investment required for ship owners. As a result the capacity to continuously track vessel movements and find their location in a short time is forsaken in favor of less expensive but more comprehensive coverage.

The basis for the computer-plotted tracking system is the acquisition of regularly updated data on vessel movements, including cargo, course, speed, and intended destination. These basic variables have been factored into a number of computer software packages each having the capacity to project the likely location of a ship, with accuracy varying as a function of the currency of the data made available. Three alternative approaches were investigated for potential in the tracking of food grain shipments: (1) tying into systems operated currently by the U.S. Coast Guard and Federal Maritime Administration which are intended primarily for the purposes of search and rescue; (2) utilizing existing commercial software packages that assemble publicly available information on ship movements worldwide; and (3) expanding deployment of the techniques used by the U.S. Department of Agriculture and Agency for International Development for tracing the movement of P.L. 480 food aid commodities to the remainder of the international food aid shipments.

U.S. Government maritime tracking operations. Two agencies of the U.S. government, the Maritime Administration and the Coast Guard, currently operate programs which maintain up-to-date information on the arrivals, departures and (periodic) at-sea locations of merchant shipping, based on standardized radio reports submitted by the ship-to-shore stations. The Maritime Administration program exists essentially for keeping agencies of the Federal Government informed concerning the locations of U.S. flag or U.S.-owned vessels throughout the world, while the Coast Guard program is intended solely to facilitate at-sea search and rescue efforts for ships in distress. With slight modifications, both systems could be employed to track food grain shipments.

The fundamental attraction of an AMVER or USMER system (abbreviations for the systems used by the Coast Guard and the Maritime Administration respectively) is that it provides a relatively high degree of accuracy in position plotting without making heavy demands on ship

operators. Participation in the case of USMER is, of course, mandatory, while with AMVER shipmasters and owners have the incentive of Coast Guard emergency protection. There is uncertainty, however, as to whether shipowners would be as willing to participate in the AMVER system if they were required to disclose the nature of their cargo; and, since search and rescue is the primary objective, it is logical that the Coast Guard's first priority must be to keep the participation rate as high as possible.

Commercial shipping-locator software packages. Information on merchant ship arrivals and departures is of interest to insurance agents and others, and a number of commercial publications list much of the same information recorded in AMVER. Information is assembled from ship brokers, insurance agents and local newspapers rather than shipmasters. Of greatest interest is the "Ship Movement Library", part of a Maritime Data Network, a joint venture of five companies including Lloyd's Register of Shipping and Marine Management Systems Inc. Under a worldwide computer time-sharing system one could, for a minimal fee, request by a local telephone call the names of all ships loading grain in U.S. west coast ports, for example, or of all grain-carrying ships headed toward the east coast of Central America. The data are much less up-to-date and less reliable than AMVER's, but are easily obtained at low cost.

AID/USDA food aid tracing system. The U.S. Department of Agriculture (USDA) and Agency for International Development (AID) have developed fairly sophisticated procedures for tracing the movements of cereal grains shipped for U.S. food aid. Since the U.S. contribution represents such a large portion of the total world food assistance, this centralization might (and often does) make the difference in an emergency situation.

AID officials claim that they can generate a computer print-out of ships, cargo type, and gross tonnage within the course of a single working day. Once it has been determined which ships are in a position to respond quickly and effectively, the Agency would contact one of the voluntary agencies such as CARE, Inc., or the World Food Programme, depending on who was managing the food aid, and seek permission to divert the cargo. Normally this procedure can be accomplished within 24 hours, at which point AID then contacts the ships' owners or agents, who in turn contact the ships directly. The system is sufficiently effective that, in the case of the Nicaraguan earthquake, ships reportedly were diverted at sea on the same day the disaster occurred. In the case of the 1976 Guatemalan earthquake, ships apparently were diverted within two days.

Model Three: Regional Emergency Food Grains Reserves

For financial and other reasons, obtaining the voluntary cooperation and participation of shipowners and shipmasters would be a major

obstacle in all of the aforementioned alternatives except for the U.S. food aid management system. The problem is not so much that the maritime community is unwilling to be of assistance in legitimate, humanitarian situations, but simply that there are certain costs (e.g., new equipment, labor time) involved in participating in a system that requires regular position reporting and possible course deviation. In the merchant shipping industry, as in any other profit-making business, little is done solely on the basis of altruism.

It is therefore worth examining whether the basic notion of diverting ships at sea is the most feasible long-term approach to the problem of supplying adequate food in international disaster situations. It might be more cost-effective instead to establish and store modest, regional food reserves in areas of the world where the margin of resources available to deal with unforeseen emergencies is limited or non-existent. In theory, regional emergency reserves could be mobilized quickly and moved to the disaster zone. This third model would avoid the problems of tracking or diverting food grain shipments at sea, and the need to coordinate the actions of a large number of diverse, unrelated parties (i.e., ship-brokers, owners, masters, government officials, and so on).

Two principal technological approaches have been proposed for the storage of regional emergency food stocks. Neither model has, to the author's knowledge, ever been costed out fully. The first and more conventional alternative would be to construct facilities to store the food grains in a centrally located, easily accessible port in each "high risk" area in the developing world. In the event of a regional disaster or food emergency, the commodities could then be loaded onto barges and towed by ocean-going tugs either to a port near the affected area or directly inland on a navigable river.

A second alternative would be to purchase or charter idle oil tankers to be used as "floating silos" for the storage of grain in high risk areas. The most obvious advantage of this approach is that it would avoid the need for double-loading of the grain required with a land-based reserve. That is, a tanker silo could be loaded at the donor country's port, sailed across the ocean, and moored in a "semi-mothballed" status to await use in an emergency. It has also been suggested that, if the tanker silos were purchased rather than rented, the propulsion units could be removed and special automatic off-loading equipment could be installed that would make this storage method far cheaper than the construction and maintenance of land-based grain elevators.

Although either of the two alternatives proposed would avoid most of the logistical problems raised in models one and two, each would also raise an entirely new set of difficulties. First, depending on the geography of the particular region and the spatial separation of

the reserve stocks, it is not clear that this model would represent a substantial time saving over the diversion of ships steaming in the vicinity. Second, both storage methods involve major, unanswered questions regarding who would pay for the storage, rotation and transportation of the grain, and who would decide under what conditions the stocks would be released. Third, there are logistical problems with both approaches: the land-based system requires double trans-shipment and expensive storage facilities; while tanker silos could be extremely expensive if chartered. The use of the tanker *Manhattan* as a floating silo for 4 months during the Bangladesh emergency, for example, cost USAID approximately $19,000 per day. Use of floating storage vessels would also have to confront the fact that large tankers are too deep of draft to be sailed or towed directly into many of the ports in developing countries, although it might be possible to circumvent this problem by designing special, shallow-draft tankers for use as silos.

Problems of Implementation

In considering the various methods for diverting grain, either in loading or already at sea, the most fundamental problem is that of obtaining the rights to the commodities. The grain companies do not monitor the movement of their commodities once the ownership papers have been passed to the buyer. Even in the case of diverting grain shipped as aid, it is necessary to re-negotiate with the ship's owners regarding extra steaming time, special insurance, special unloading costs, and perhaps even the price of the cargo itself. If a ship must enter a war zone, there may be particularly severe insurance problems. Many foreign flag vessels may, in fact, refuse entirely to be diverted under these conditions.

A second set of problems concern the draft of grain ships and the availability of deep water ports. On the average, a typical bulk carrier will transport a cargo of 25,000-40,000 tons, but one particular U.S. shipment to India actually exceeded 105,000 tons; this ship was forced to anchor nearly 5 miles off-shore for unloading. The tanker *Manhattan*, used in the Bangladesh relief operation, had to anchor with its 66,063 ton cargo fully 14 miles from the nearest land, and 56 miles or 8 hours steaming time from the main port of Chittagong. A tanker or bulk carrier may cost $10,000-20,000 per day to operate whether it is moving or anchored.

A third set of problems relates to the unloading process itself. Even if a ship is able to enter the port nearest a disaster zone, automated, high-speed off-loading equipment may not be available. This will require, therefore, that a diverted ship possess or obtain access to portable "vacuvators," mechanical devices used to suck the grain out of the hold.

Finally, there is the problem of how the grain will be moved from the vessel once it is unloaded. Particularly in the case of large ships which are unable to enter port, some form of lighter ship or barge will be required. In the case of the Bangladesh emergency, good results were obtained with the use of so-called "minibulkers," which are miniature versions of the big, ocean-going bulk carriers, designed originally for use on the Mississippi River. Between June and November 1972, these vessels unloaded more than 100,000 tons of grain per month.

Conclusions and Recommendations

Food relief in disaster situations is, in reality, a two stage process. There are, first, the immediate post-crisis food requirements, which may only be met with reserve supplies on hand or through the use of air-cargo planes; and second, there are also the continuing food needs of the affected population which must be attended to until normal production and distribution channels can be re-established. Since the three approaches considered here have little or no application to the former situation, it may be concluded that the technologies designed to track actual ship positions using satellite remote sensing (i.e., Model One) are more sophisticated and, therefore, more expensive than is warranted for the purposes of longer term post-disaster food supply. Moreover, large scale international disasters fortunately do not occur with great enough frequency to justify either the investment in or the deployment of such a system.

On this basis, some variation of Model Two, the computerized locator system, would seem much more appropriate than Model One to the problem at hand. Since there does not appear to be any over-riding need to track the position of grain shipments at all times, it would seem that any system capable of plotting reliably the approximate position of all grain carrying vessels in a particular geographic region would be satisfactory. The question then becomes one of the degree of reporting accuracy relative to the level of cooperation and participation required of ship owners and operators. It stands to reason that the system (or systems) requiring the least inconvenience to the maritime community, while still generating accurate data on ship positioning, would be the most likely to succeed.

The computer software packages currently maintained by Marine Management Systems, Inc. and by AID would appear to meet these criteria. Both systems have certain advantages: the Marine Data Network offers the more current reporting and also facilitates easy global access through an international computer time-sharing system; the AID food aid management system, on the other hand, is already geared to tracking the specific movement of U.S. food aid commodities. It is possible that a synthesis of the two approaches (i.e., one which encompassed the food aid offered by other bilateral donors as well)

might represent the most feasible short range solution, offering the capability of locating and diverting ships at sea within a 24-48 hour period.

In the longer term (5-10 years), a better coordinated system of food tracing could be augmented profitably by the creation of a limited number of regional emergency food reserve stocks. Based on the information currently available, it would appear that a more conventional land-based storage facility, employing barges or minibulkers to move the food grain, would be the most practical alternative. Such a system could be integrated with the International Emergency Reserve program administered by the WFP, thereby permitting multilateral sharing of the costs associated with maintaining reserve stocks. In fact, since only a limited number of donor countries are normally in a position to provide the actual commodities for a physical reserves stock, it might be particularly appropriate for the other, non-food-exporting developed countries to supply the capital needed to pay for storage, maintenance and transport of food reserves.

A word about implementation is also in order. While the majority of physical problems may be overcome through intelligent design of the system that recognizes the constraints at hand (e.g., port capacity and so on), institutional difficulties are less amenable to change. It would seem that, in terms of present responsibilities and expertise, the UN-FAO World Food Program is the logical focal point. This alternative is made all the more attractive by the apparent willingness of AID to share its technical expertise in the development of an international food tracing system. The WFP represents the most logical organizational framework within which to operate a computerized locating system in order to encourage contributions by all the donor countries--not just the U.S. Finally, in the longer term, expansion of the present WFP International Emergency Reserve to include a modest, tangible supply of regionally-based emergency food stocks could remove the need for at-sea diversions of food grain shipments in all but the most extraordinary of circumstances.

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